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Arab Republic of Egypt
Ministry of Education
&Technical Education
Central Administration
of Book Affairs

BIOLOGY

Grade 1 Secondary

Student Book

2018 - 2019

Book cover



Expresses the human blood cells

BIOLOGY

Grade 1 Secondary

Student Book

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2018 - 2019



Center For Curriculum & Instructional Materials Development

مقدمة الكتاب

أبناءنا وبناتنا طلاب الصف الأول الثانوى ، شهدت الأعوام الأخيرة طفرات هائلة ومستحدثات تكنولوجية فى شتى مجالات الحياة ، وكان على المنظومة التعليمية بجمهورية مصر العربية أن تواكب هذه المستحدثات متأثرةً بهذا التطور الهائل.

لذلك حرصت وزارة التربية والتعليم على تطوير المناهج على اعتبار أن المنهج كائن يلزمه التجديد والتحديث ليتوافق مع متغيرات العصر وذلك بهدف إعداد جيل قادر على مواكبة هذه المستحدثات ، بل تكون له القدرة على استخدامها فى ابتكار ما هو أحدث.

وقد راعينا فى إعداد هذا الكتاب تغيير دور المتعلم لنخرج به من حيز المتلقى إلى مجال المتفاعل النشط من خلال قيامه بالبحث والاستقصاء والمقارنة والاستنباط واكتساب المهارات وغرس حب المعرفة حتى يصبح فردًا فعالًا فى المجتمع ؛ وذلك لتحقيق الاكتفاء الذاتى لوطنه اقتصاديًا وثقافيًا واجتماعيًا ، وذلك من خلال التنوع فى الأنشطة والمهارات بهدف إعداد جيل متنوع من الطلاب يخدم الوطن فى كافة المجالات .

ويتضمن الكتاب أنشطة فردية وجماعية ، معملية وتطبيقية لتحقيق أهداف المنهج. وينتهى كل فصل بأنشطة تقويمية حتى يقف الطالب على ما تحقق من أهداف وما يجب القيام به من أعمال لتحقيق ما لم يتم تحقيقه ، وقد راعينا فى إعداد هذا الكتاب التسلسل المنطقى لأبواب المنهج ، وكذلك التدرج فى مستوى هذه الأنشطة مراعاة للفروق الفردية والحاجات والميول المختلفة.

وقد تم عرض هذا المنهج فى شكل نسيج متكامل ومترابط فى ستة أبواب تبدأ بعلم الكيمياء وطبيعته وعلاقته بالعلوم الأخرى ، وخاصة الحديث منها مثل : علم النانو تكنولوجى ، ثم توالت أبواب المنهج مرورًا بالكيمياء الكمية ثم المحاليل والأحماض والقواعد ، يليها الكيمياء الحرارية ، ثم الكيمياء النووية.

وقد تم تزويد الكتاب بروابط على بنك المعرفة المصرى

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منها ما هو فى سياق الموضوعات ، ومنها ما هو إثرائى لتعميق المعرفة والفهم تشجيعًا لكم على المزيد من البحث والاطلاع.

ونحن إذ نقدم هذا الكتاب لكم نتمنى أن يحقق ما تصبو إليه رغباتكم ويشبع ميولكم ويلبى احتياجاتكم ، متمنين أن يتحقق لمصرنا الغالية الرخاء والإزدهار.

والله ولى التوفيق ،

المعدون

Contents

Unit One : Chemical basis of life



Unit Two: Cell: structure and function







Unit One

Chemical Basis of Life

Biology is closely related to chemistry. Chemistry explains the chemical structure of living organisms and the reactions taking place inside their cells.

There are four basic types of organic molecules necessary to the life of living organisms. These molecules are carbohydrates, proteins, lipids, and nucleic acids. All living organisms are made up of these four molecules. These four molecules are called the biological macromolecules.

In this unit, you will identify the molecular structure, functions and importance of these molecules to the living organisms. Furthermore, you will identify the chemical processes related to the functions of life.

In this unit, you will practise some practical and applied activities that help you to understand the nature , structure and functions of the biological macromolecules and the chemical reactions which occur inside the cells. These activities improve some of your skills such as observations, experimentation, measurement, conclusion, interpretation, controlling the variables and so on.

For more information about the topic of chemical basis of life, log in the net.

Time Management

To achieve the maximum benefit of this unit, you need to:

- Manage your time among practical and theoretical study, research and the expansion of information resources.
- Carefully, record the results of your practical study because they are the ideal way to support your learning.

Learning Outcomes

By the end of this unit, the student should be able to:

- Determine the substances from which the living organism's body are made up of.
- Describe the molecular structure of carbohydrates, lipids, proteins, and nucleic acids.
- Determine the functions of carbohydrates, lipids, proteins, and nucleic acids.
- Explain the role of monosaccharides in the processes of transferring energy inside the cells of living organisms.
- Explain the relationship among the sequence of amino acids in the polypeptide chains, and the structure and variation of the proteins.
- Identify carbohydrates, lipids, and proteins practically.
- Determine what is meant by metabolism in living organisms (catabolism and anabolism).
- Determine what is meant by enzymes and mechanisms and principles of their functions.
- Explore the effect of the pH on the enzymes activity.
- Clarify the effect of temperature on the enzyme activity practically.
- Appreciate the grandeur of Allah for the accurate structure of living organisms' bodies.

Chapter 1: Chemical structure of living organisms' bodies(carbohydrates and lipids)

Chapter 2: Chemical structure of living organisms' bodies(proteins and nucleic acids)

Chapter 3: Chemical reactions in living organisms' bodies

Unit One

Chapter 1

Chemical Structure of Living Organism's Bodies

(Carbohydrates and Lipids)

By the end of this chapter, you should be able to:

- Determine the substances from which the living organism's body is made up of.
- Describe the molecular structure of carbohydrates and lipids.
- Determine the functions of carbohydrates and lipids.
- Explain the role of monosaccharides in the processes of transferring the energy inside the cells of living organisms.
- Identify carbohydrates and lipids practically.
- Propose scientific hypotheses and do experiments to verify their validity.

Terms:

- Carbohydrates
- Monosaccharides
- Disaccharidase
- Polysaccharides
- Lipids

You know that the structure of living organisms comes in gradual levels. These levels begin with the systems, organs, tissues, cells and finally come the organelles.

If we follow up this structural sequence of living organisms, we will find that the cells of any living organism are made up of organic and inorganic molecules and each of these molecules is made up of atoms as well.

Inorganic molecules in living organisms such as water and salts often do not contain carbon atoms. While organic molecules such as carbohydrates, lipids, proteins, and nucleic acids are large molecules containing carbon and hydrogen, and called biological macromolecules.



Figure 1: Sucrose molecule is one of the biological macromolecules.

Use the colour key attached to figure 2 to identify the cell organelles that made up of:

(Carbohydrates-lipids - proteins -and nucleic acids).

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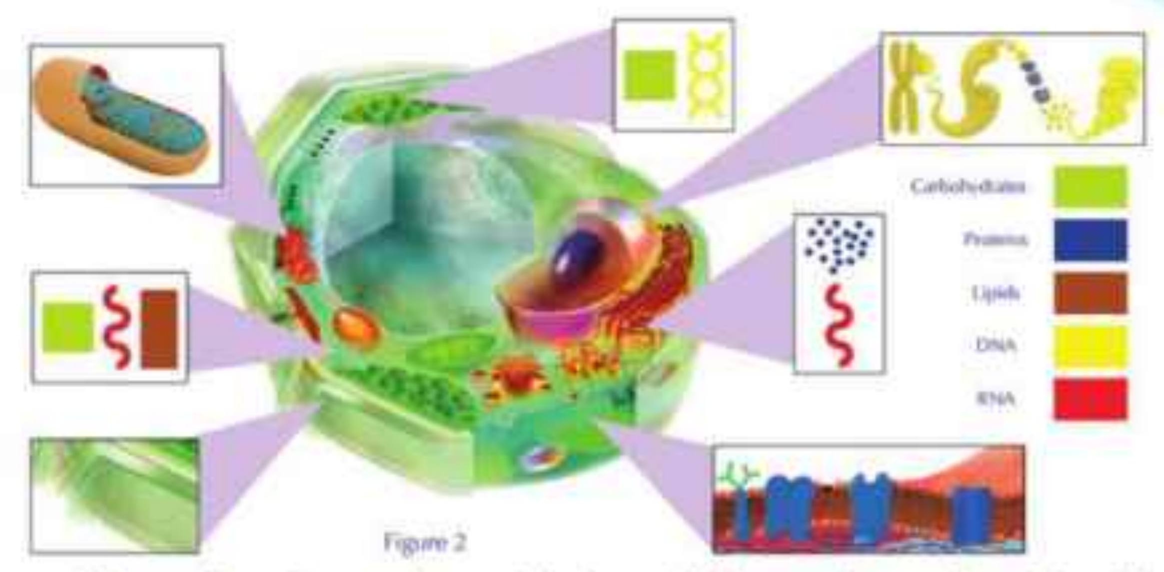


Figure 2

Observe figure 3 to see that carbohydrates, lipids, proteins , and nucleic acids are made up of units. Each unit is made up of smaller units. Identify the units from which all the four biological macromolecules (carbohydrates, proteins, lipids, and nucleic acids) are made up of.

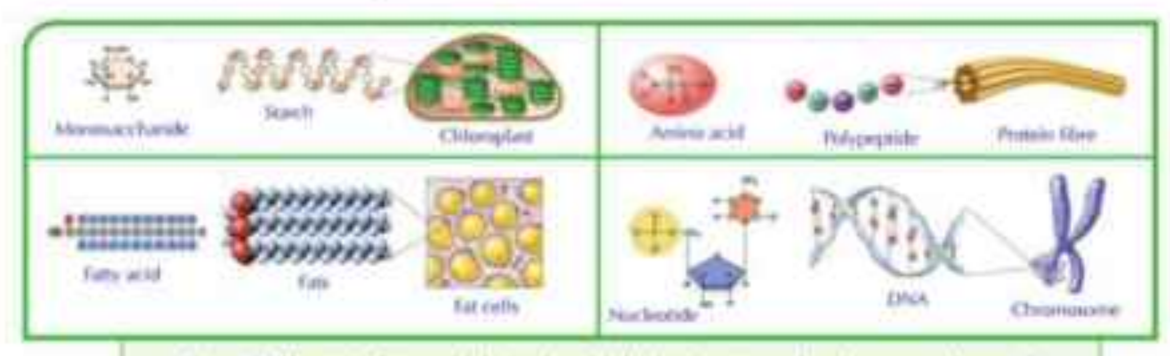


Figure 3: The units from which the four biological macromolecules are made up of.

Biological macromolecules

Biological macromolecules are large-sized organic compounds made up of smaller molecules. All these compounds contain the carbon element and they are extremely necessary for the life of living organisms.

Most biological macromolecules are called polymers. Polymers are made up of the combination of smaller molecules called monomers throughout a process called polymerization.

Enrichment

Biochemistry: is the science concerning with studying the chemistry of living organisms. .

Biological macromolecules are divided into four groups according to their molecular structures and the functions they perform.

Carbohydrates

Carbohydrates are biological macromolecules made up of smaller molecules called monomers. Carbohydrates include sugars, starches and fibres. They are symbolised by the formula $(CH_2O)_n$. According to this formula, carbohydrates are made up of carbon (C), hydrogen (H) and oxygen (O) atoms in the ratio 1:2:1.

Importance of Carbohydrates:

✲ **Carbohydrates and obtaining energy:** Carbohydrates are considered the fast and basic resources for obtaining the energy.

✲ **Carbohydrates and storing energy:** Carbohydrates are used for storing energy in living organisms' bodies until they require it. Plants store carbohydrates in the form of starches. On the other hand, the carbohydrates are stored in the human body and animal's body in the form of glycogen in the liver and muscles.

✲ **Carbohydrates and building the cells:** Carbohydrates are a basic component for some parts of the cell such as cellulose in the root of plant cells. Additionally, carbohydrates are also found in cell membranes and in the protoplasm of the cell.

Molecular structure of carbohydrates:

There are several ways to classify carbohydrates. Some of these classifications are based on the molecular structure of these carbohydrates. They can be divided into:

➡ **Simple sugars**

✲ It's chemical composition is made up of either one of sugar molecules and called monosaccharides or made up of two molecules of monosaccharides linked together to form a molecule of disaccharidase .

✲ **Monosaccharides**

Monosaccharides are the simplest type of sugars. They are made only up of one molecule. This molecule is made up of a chain of carbon atoms. Each carbon atom is connected to oxygen and hydrogen atoms in a certain way. The number of carbon atoms in monosaccharides ranges from 3-6 atoms.

Figure (4): Glucose is one of the monosaccharides (observation only).

- Examples for monosaccharides are glucose (fig.4), fructose, galactose, and ribose.

✲ Disaccharidase

✲ Two monosaccharides molecules are linked to each other to form a disaccharide molecule. Examples for disaccharidase are sucrose, which is made up of a glucose molecule linked to a fructose molecule, lactose which is made up of a glucose molecule and a galactose molecule and maltose which is made up of two glucose molecules.

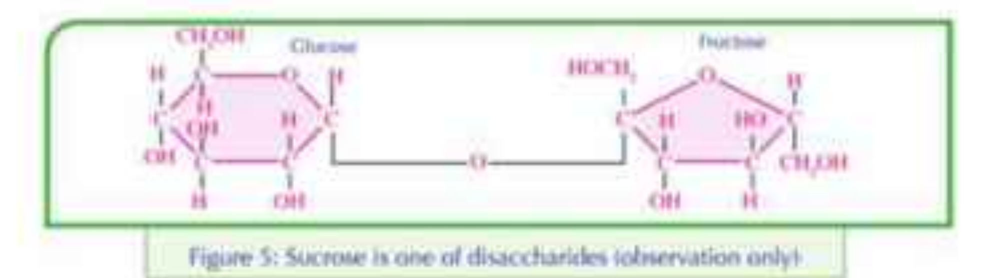


Figure 5: Sucrose is one of disaccharides (observation only)

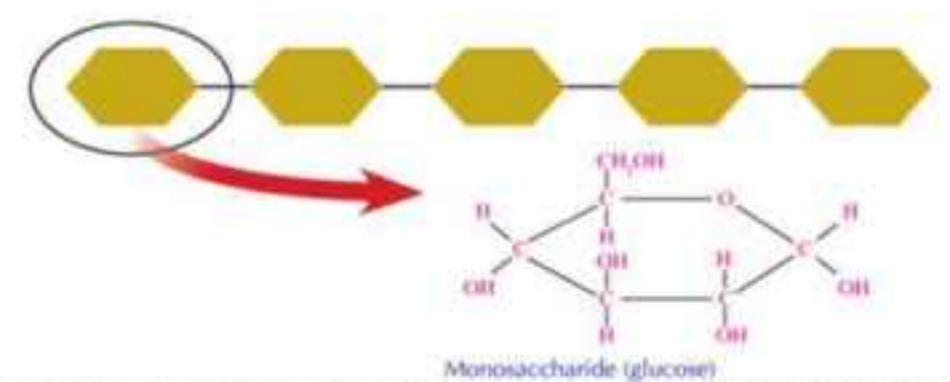
In general, simple sugars are soluble in water, have a low molecular weight and have a sweet taste.

✲ Role of monosaccharides in the processes of transferring energy inside the cells of living organisms.

Living organisms obtain energy stored in carbohydrates when the glucose molecules are oxidised inside the cells (mitochondria) and the energy stored in its chemical bonds released in the form of a compound called adenosine triphosphate (ATP). This compound is transferred into other places in the cell to use the stored energy in it for all the vital processes inside the cell.

Second: Complex sugars

Complex sugars are polysaccharides made up of monosaccharides such as starch, cellulose and glycogen. Each of them is made up of glucose molecules combined with each other. Complex sugars are insoluble in water, have high molecular weight, and do not have sweet taste.



Monosaccharide (glucose)

Figure 6: Complex sugars are made up of several monosaccharides (glucose) (observation only)

Lipids

Lipids are biological macromolecules made up of carbon, hydrogen and oxygen atoms. Lipids are also made up of a large group of heterogeneous compounds such as fats, oils, waxes, phospholipids and the derived lipids such as steroids. All these compounds are insoluble in water, but they dissolve in the nonpolar solvents such as benzene and carbon tetrachloride.

Molecular structure of lipids

Observe figure 7 to see that the lipids are made up of fatty acids, and glycerol. Glycerol is an alcohol containing three hydroxyl groups (OH).

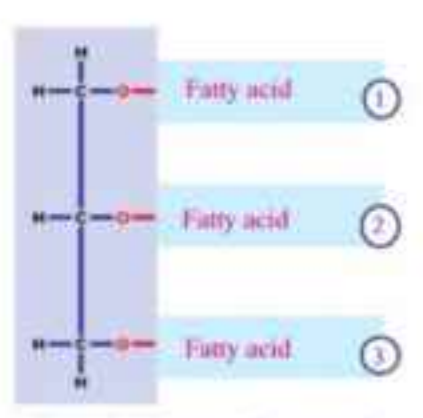


Figure 7: A diagram illustrating the molecular structure of lipids (observation only)

Importance of lipids

* Lipids and obtaining energy

However, carbohydrates are a rapid resource of energy, the energy obtained from lipids is more than the energy obtained from the same amount of carbohydrates. The body does not begin to get the energy from the fats stored in it, only in case of the absence of carbohydrates.

* Lipids and building the cells

Lipids represent about 5% of the organic materials involved in the composition of the living cell. Lipids also have an important role in the structure of cell membranes.


Figure 8: Lipids form isolating layers under the skin

Furthermore, lipids work as a thermal insulator in animals and humans. Due to the favour of lipids, organisms can maintain their temperatures in severe cold regions. Besides, lipids can work as a protective cover for the surfaces of several plants and animals, and some of them can work as hormones as steroids.

Classification of lipids:

According to the chemical structure, lipids are classified into:

Simple lipids

Simple lipids are formed by the reaction of fatty acids with alcohols. According to the saturation degree of the fatty acids and the type of alcohol, simple lipids are divided into:

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 Oils

Oils are liquid fats formed by the reaction of unsaturated fatty acids with glycerol. Examples for simple lipids are the liquid fats covering the feathers of water birds to prevent water penetration into their bodies, (figure 9).



Figure 9: Feathers of water birds

 Fats

Fats differ from oils in the aspect of being solid substances. Fats are formed by the reaction of the saturated fatty acids with glycerol.

Enrichment

Risks of the takeaway food

Ready meals, fried food, and many bakeries and sweets contain a type of fat called trans fat that produced by hydrogenation of vegetable oils. Frequently eating of these fats leads to elevation of cholesterol concentration in blood.

 Waxes

Waxes are made up by the reaction of fatty acids of high molecular weight with monohydric alcohols. For example, the waxes covering the desert plant leaves to reduce water loss during the transpiration.



Figure 10: The wax covering the plant leaves.

✲ Complex lipids

Hydrogen, carbon and oxygen are involved in the structure of complex lipids, in addition to phosphorus and nitrogen as in phospholipids.

Phospholipids:

They are present in cell membranes of animals and plants. They are similar to fat molecules in the structure except for the phosphate group PO_4^{--} and choline which replaces the third fatty acid (figure 11).

✲ Derivative lipids:

They are lipids derived from both the simple and complex lipids by hydrolysis such as cholesterol and some hormones.

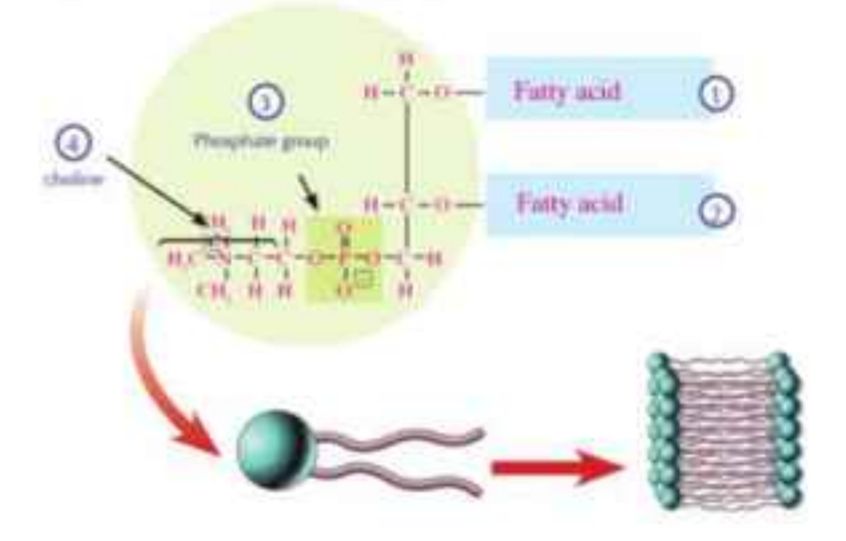


Figure 11: Phospholipids
(observation only)

Practical activity 

Detection of sugar

Safety precautions

Activity goal

Reveal the presence of sugar in different food samples using the blue Benedict's reagent (turns orange in presence of simple sugars)

Acquired skills

Hypothesizing, experimenting, concluding, observing, interpreting

Materials needed

Water bath, burner, 4 test tubes, tube rack, glucose solution, starch solution, egg albumin, distilled water, Benedict's reagent, pen, tube handler.

Share your group in this activity.

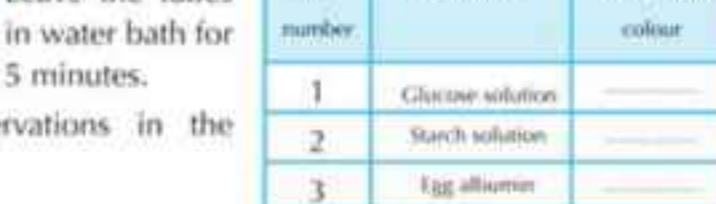
Procedure:

➡ Hypothesizing:

In light of the goal of this activity, which substance (s) you have contain a monosaccharide? ________

➡ Test the validity of your hypothesis:

1. Label test tubes 1 - 4 .
2. Put 2 ml of glucose solution, starch solution, egg albumin, and distilled water, respectively in the tubes .
3. Add 2 ml Benedict's reagent to each tube.
4. Leave the tubes in water bath for 5 minutes.



Tube number	Substance	The resulted colour
1	Glucose solution	________
2	Starch solution	________
3	Egg albumin	________
4	Distilled water	________

5. Write down your observations in the opposite tabel:

➡ Conclusion:

- Which tube (s) give positive results (turns to orange) and which is negative (colour is not changed)? ________
- What is the relation of your results with your hypotheses? ________
- What do you conclude from the experiment? ________
- Does the starch colour change by adding Benedict's reagent? Why? ________
- Which of the previous substances must be avoided by diabetic and obese pacients ? ________
- How can Benedict's reagent be used in the different situations of actual life? ________

Applied activity



Detecting the starch

Sefety precaution



Activity goal

- Use your skills in detecting the presence of starch in some foods you are taking by using iodine solution (iodine turns blue in presence of starch)

Acquired skills

Experimenting, observing, inferring, explaining, classifying

Materials needed

Samples of foods: Milk powder, pea seeds, soybean grains, sucrose sugar, green apple, tomatoes, carrots, celery, macaroni, bread, iodine solution and a dropper .

Support your opinion with the results of the experiment then do a report to show your classmates.

Procedure:

By using iodine solution, detect the presence of starch in samples you have.

Note: Some materials such as: Soybeans, macaroni and wheat needs grinding.

Observation:

Design a table to write down the change in iodine colour in each case.

Classifying:

In a table, classify the foods you tested into 2 categories according to their content of starch ....

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Practical activity 

Detecting lipids

Safety precautions



Activity goal

Detect the presence of lipids in different samples of foods using sudan - 3 reagent (a stain soluble in fats and turns red in presence of fats))

Acquired skills

Hypothesizing, experimenting, concluding, observing, explaining

Materials needed

Sudan-4 stain, potatoes, bean seeds, castor seeds, distilled water, 4 pipettes, adhesive paper, mortar and 4 test tubes

Participate your group in this activity.

Procedure:

➡ Hypothesizing:

In light of this activity goal, which substance (s) you have contain lipids?

....

....

....

➡ Test the validity of your hypothesis:

1 Cut a small piese of potato, then cut it into smaller pieces. Put the pieces in a mortor and grind. If you need, you can add 2ml of distilled water to facilitate grinding. Collect the resulted juice in a test tube and label potato juice.

2 Using another mortar, grind bean seeds, and repeat the previous step with peanut seeds. You can add 2 ml distilled water for each.

3 In a test tube, put 2 ml of what resulted from bean seeds grinding. In another tube, put 2ml of what resulted from peanut seeds grinding. In a third tube put 2ml distilled water.

4 Add 2ml of sudan -4 stain to each tube.

➡ Write down your observations in the table:

No	Substance	The resulted colour
1	Potato	
2	Bean seeds	
3	Peanut seeds	
4	Distilled water	

➡ Conclusion:

- Which substance (s) tested contain fats? What is the relation of your results with your hypothesis? ....

....

- How can sudan-4 indicator be used in the actual life situations?

....





Unit One
Chapter 2
Chemical Structure of Living Organism's Bodies (Proteins and Nucleic Acids)

By the end of this chapter, you should be able to:

- Describe the molecular structure for both proteins and nucleic acids.
- Determine the functions of both proteins and nucleic acids
- Explain the relationship between the sequence of amino acids in the polypeptide chains and the composition of proteins and their variation.
- Identify the primary, secondary, tertiary and quaternary structure of proteins.
- Identify proteins practically.
- Propose scientific hypotheses and do experiments to verify their validity.

Terms

- Protein
- Amino acids
- Polypeptide
- Primary structure
- Secondary structure
- Tertiary structure
- Quaternary structure
- Nucleic acids
- Nucleotides

Proteins

Proteins represent the structural composition of all living organisms. All living organisms from the hugest animal to the extremely microscopic one are mainly made up of proteins. Proteins contribute to the biochemical processes preserving the life.

Importance of proteins

Proteins are involved in the structure and functions of the living cells. They are one of the basic components of cellular membranes. In addition, proteins form the muscles, ligaments, tendons, organs, glands, nails, hair and a lot of the vital fluids of the body such as blood and the lymph. They are necessary for bone growth. Furthermore, enzymes and hormones which stimulate and regulate all the vital processes in the body are proteins. Proteins are a basic component of chromosomes.







Figure 12: Spider's net, hoves, and horns of animals are basically made up of proteins.

Molecular structure of proteins

Proteins are complex macromolecules (polymers). They have high molecular weight and made up of structural units (monomers) which are amino acids.



Figure 13: A model illustrating the composition of proteins and amino acids

Amino acids

Amino acids are the proteins building units. They are organic compounds made up of hydrogen, oxygen,carbon and nitrogen atoms. Observe figure 14 to see that amino acids are made up of a basic group- the amino group NH_2 , an acidic group- carboxyl group COOH (Those two groups are the functional groups in the amino acid), a hydrogen atom and a terminal group R which differs from an amino acid to another.

H
|
NH_2 — C — COOH
basic group | acidic group
R

Figure 14: General formula of an amino acid

Amino acids and building of protein

Proteins are made up of repeated units of amino acids which link with each other by peptide bonds. Observe figure 15. You can observe that these bonds are present between the carboxyl group of an amino acid with an amino group of another amino acid, with the removal of water due to this combination.

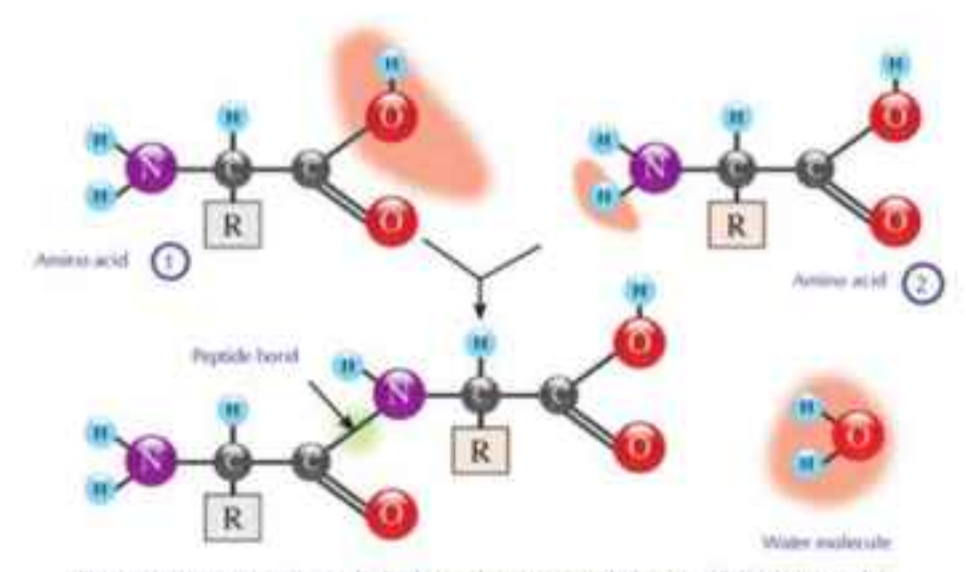


Figure 15:Amino acids are linked together by peptide bonds (observation only)

The combination of two amino acids is called dipeptide compound and the protein chain formed of several amino acids is called polypeptide. When protein is being formed, it is not conditional for the combination to occur among similar amino acids. This gives extensively wide and various possibilities to form proteins depending on types, order and number of amino acids in the chain. About 20 amino acids participate in building the proteins such as glycine, alanine and valine.

Research and expand

Log in the internet to identify the rest of amino acids involved in building the proteins. Observe and determine the type of R group in each amino acid.

Classification of proteins

Proteins are classified according to the substances involved in their structure into:

Simple proteins

Simple proteins are made up of the basic units of building protein, i.e of amino acids only such as albumin present in the leaves and roots of plants and in blood plasma of humans.

Conjngated proteins

Conjugated proteins are made up of amino acids associated with other elements such as phosphorus, iodine and iron. Besides, the nucleic proteins associated with the nucleic acids and phosphoproteins such as casein-the milk protein- which contains phosphorus. The thyroid protein (thyroxine) which contains iodine, while the haemoglobin necessary for transferring the oxygen during the respiration process contains iron.

Enrichment

The lack of albumin in the body leads at an imbalance in osmotic pressure of the cell. Also, the body retains a large amount of fluids which causes swelling especially in the feet and face because albumin prevents the leaking of fluids from blood vessels into the tissues. So, albumin maintains the osmotic pressure inside the cell.

Nucleic acids

Nucleic acids are biological macromolecules containing oxygen, hydrogen, carbon, nitrogen and phosphorus . There are two types of nucleic acids: Ribonucleic acid (RNA) and Deoxyribonucleic acid (DNA). Nucleic acids are made up of basic units called nucleotides which bind together by covalent bonds to form a polynucleotide or the nucleic acid.

Nucleotides

Nucleotides are the basic units forming the nucleic acid. Each of them is composed of three units illustrated in figure 16.

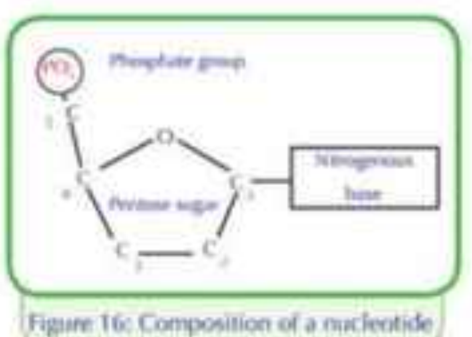


Figure 16: Composition of a nucleotide

✲ **A pentose sugar molecule:** There are two basic types of sugar in nucleic a cids:

- (A) First type: Deoxyribose sugar involved in the composition of DNA.
- (B) Second type: Ribose sugar involved in the composition of RNA.

✲ **A phosphate group**

It is connected to the carbon atom number 5 of the sugar molecule.

✲ **A nitrogenous base**

Nitrogenous bases are: adenine (A), guanine (G), cytosine (C), thymine (T) n a DNA molecule, and uracil (U) is found in RNA molecule instead of thymine. Uracil is found in RNA only instead of Thymine in DNA. Each base is connected to the carbon atom number 1 of the sugar molecule. Nucleic acids differs with respect to the difference of the nitrogenous bases forming them.

Check your skills:

Observe figure 17 and compare the nitrogenous bases of both DNA and RNA.

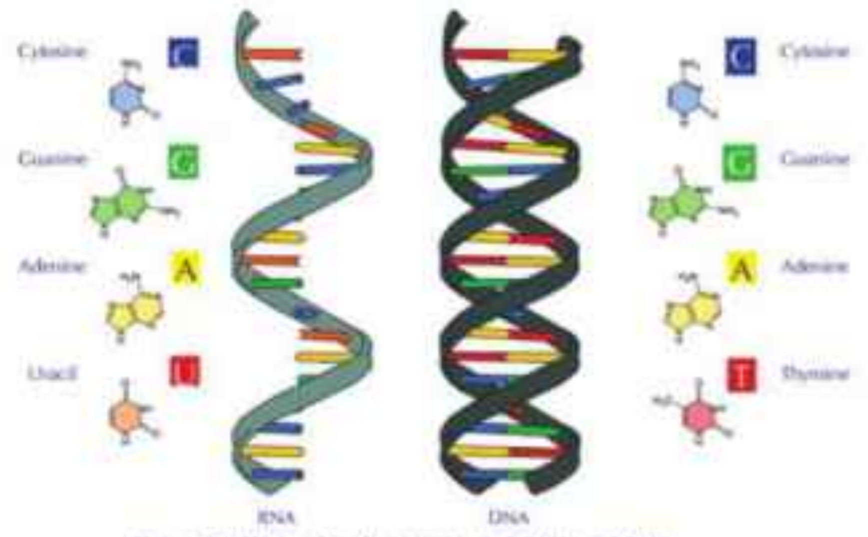


Figure 17: The molecular structure of DNA and RNA.

Importance of nucleic acids

Nucleic acids are carried on the chromosomes inside the cell nucleus. They are responsible for passing on the genetic traits from a generation to another when cells divide. DNA carries the genetic information responsible for appearing the distinctive characteristics of the living organism and organize all the vital activities of the cell.

On the other hand, RNA is transcribed from the nucleic acid DNA, then it transfers into the cytoplasm to be used by the cell to synthesize the proteins responsible for appearing the genetic traits, and those responsible for organizing the vital activities.

Enrichment

Bio computer

In field of nanotechnology, scientists arrived to that DNA can be used to make biochips and using them to make computers much faster than current devices that rely on silicon chips. Also, their storage capacity will be millions of times greater than current devices.

Activities and Excersises

Chapter 2 Chemical structure of living organisms' bodies (proteins and nucleic acids)

Practical activity 

Detection of proteins

Safety precautions



Activity goal

Detect the presence of protein using biuret reagent (blue turns to violet in presence of protein)

Acquired skills

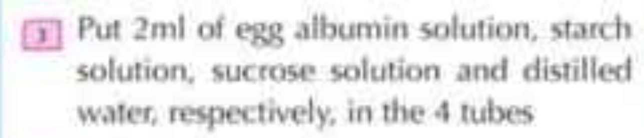
Predicting, experimenting, observing, explaining

materials needed

Biuret reagent, egg albumin, starch solution, sucrose solution, distilled water, and 4 test tubes

➡ Procedure:

1. Predict: which substance (s) you have contain protein?
2. Label test tubes 1 - 4 .
3. Put 2ml of egg albumin solution, starch solution, sucrose solution and distilled water, respectively, in the 4 tubes





4. Add 2ml biuret reagent to each tube.

	Substance	Observation
1	Egg albumin	....
2	Starch solution	....
3	Sucrose solution	....
4	Distilled water	....

➡ Record your observations in the table above:

Conclusion and analysis:

- Which substance (s) gave positive results? Which is negative?

....

....

- Compare between your observations and predictions.

....

....

- What do you conclude from this experiment?

....

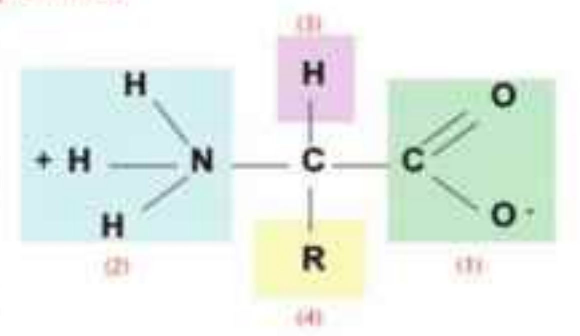
- What are the actual life situations in which biuret reagent can be used?

....

....

Assessment activity

1 The following figure represents the general formula of an amino acid. Examine the figure, then answer the following questions:



- Identify what the numbers 1-4 represent.

....

- What are the numbers that represent the functional groups in the amino acid?

....

- Which of the previous is differ from an amino acid to another?

....

....

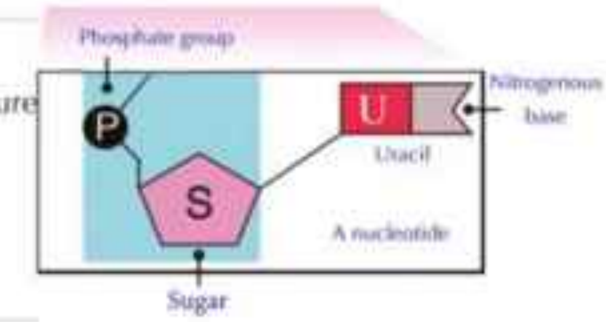
....

2 The nucleotide in opposite figure represents the building unit of:

a - DNA

b - RNA

c- DNA and RNA



Justify your answer: ....

....

....

3 Use the following table to compare between DNA and RNA :

Comparison points	DNA	RNA
Type of sugar		
No. of strands		
Nitrogenous bases		
Importance		
Site		

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Unit One

Chapter 3

Chemical Reactions in Organisms' Bodies

By the end of this chapter, you should be able to:

- Identify what is meant by metabolism in living organisms (catabolism and anabolism).
- Identify what are meant by enzymes, the principle, and mechanism of their action.
- Explore the effect of hydrogen ion concentration (pH) on the enzymes' activity.
- Show the effect of temperature on the enzyme activity practically.
- Clarify the grandeur of Allah in the accurate structure of living organisms' bodies.

Terms

- Metabolism
- Catabolism
- Anabolism
- Enzymes
- pH
- Optimal pH

Biochemical reactions necessary for growth, repairing damaged tissues, and obtaining energy take place in all living organisms' bodies. These reactions are called metabolism and they continue in all living organisms. If they stop working, this leads to death of the organism.

Metabolism

Metabolism is a group of biochemical processes take place inside the cell. In these processes, complex and macromolecules are being built from simple molecules and called anabolism. On the other hand, some molecules get broken down to extract chemical energy stored in it and called catabolism.

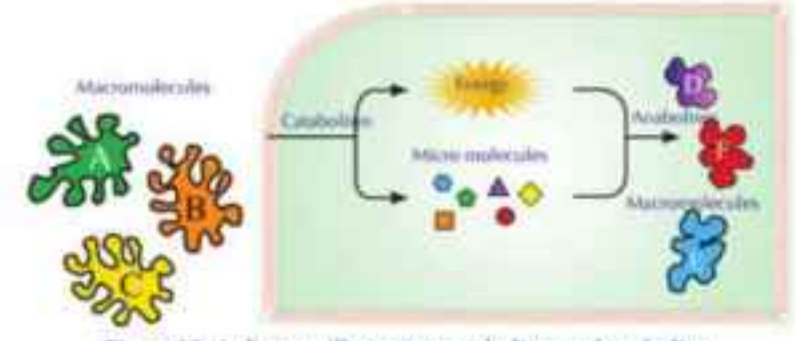


Figure 18: A diagram illustrating catabolism and anabolism

First: Catabolism

Catabolism is the process of releasing energy stored in the chemical bonds present in the molecules such as glucose.

Second: Anabolism

In the process of anabolism, simple molecules are used to build up more complex substances throughout a chain of reactions. These reactions consume energy such as synthesis of proteins from the amino acids.

Enzymes

All the reactions occurring in living organisms require high activation energy to take place. To reduce the cell consumption to more energy, there should be a catalyst to be sure that the chemical reaction occurs rapidly throughout reducing the activation energy. This catalyst is the enzymes.

Activation energy

The minimum energy needed in order for a chemical reaction to occur.

Figure 19 illustrates the consumption of a biochemical reaction to the energy in the presence and absence of the enzyme.

* Compare the activation energy of the reaction in the presence and absence of the enzyme.

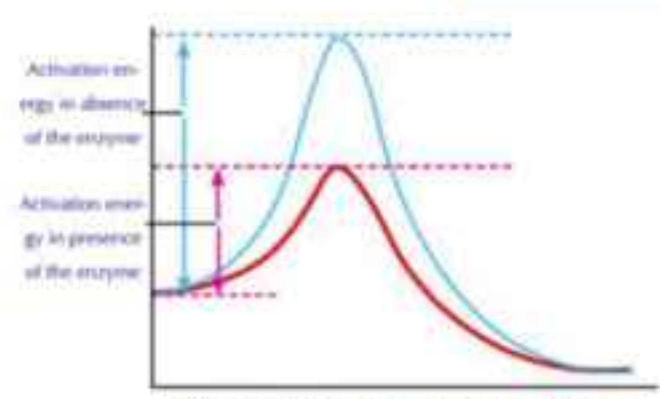
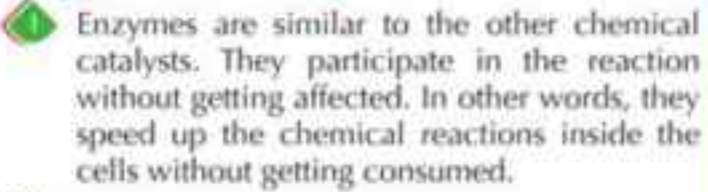


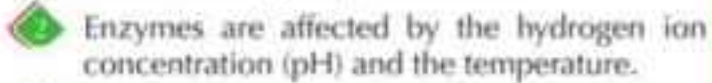
Figure 19: Effect of enzymes on the energy consumed in the reaction

Enzymes are biological catalysts made up of large protein molecules. They speed up the chemical reactions inside the cell. The enzyme is made up of a combination of a great number of amino acids forming a chain or more of polypeptide between each other.

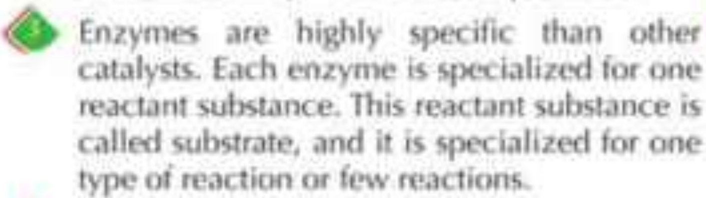
Properties of the enzyme



1. Enzymes are similar to the other chemical catalysts. They participate in the reaction without getting affected. In other words, they speed up the chemical reactions inside the cells without getting consumed.



2. Enzymes are affected by the hydrogen ion concentration (pH) and the temperature.



3. Enzymes are highly specific than other catalysts. Each enzyme is specialized for one reactant substance. This reactant substance is called substrate, and it is specialized for one type of reaction or few reactions.



Figure 20: The three dimensions shape of an enzyme

4. Enzymes lower the activation energy required to get the reaction started.

Factors affecting the enzymes action

There are several factors that affect the speed of enzymes action such as: concentration of the enzyme, concentration of substrate, temperature, hydrogen ion concentrayion (pH), and the presence of inhibitors.

The following is an illustration to the effect of some of these factors on the speed of enzyme action:

*The relationship between temperature and enzymes activity

Figure 20 illustrates the relationship between the activity of two enzymes and temperature. Observe the figure and identify the following:

- The temperature at which each enzyme starts its activity.
- The temperature at which the maximum activity of each enzyme appears.
- The temperature at which the activity of each enzyme gets stopped.
- The thermal range of each enzyme's activity.

Figure (20): The relationship between temperatures and enzyme activity.

The protein nature of the enzymes makes them extremely sensitive to the thermal changes. Enzymes activity is determined in a narrow range of temperatures comparatively to the ordinary chemical reactions. As you have observed, each enzyme has a certain temperature at which the enzyme is more active. This point is called the optimal temperature which ranges between 37 to 40C°.

The enzyme activity gradually lowers, as the temperature raises more than the optimal temperature until it reaches a certain temperature at which the enzyme activity stops completely due to the change of its natural composition.

On the other hand, if the temperature lowers below the optimal temperature, the enzyme activity lowers until the enzyme reaches a minimum temperature at which the enzyme activity is the least. The enzyme activity stops completely at 0 C°, but in case of raising the temperature, the enzyme gets reactivated once more

Life application

Temperature degrees are sometimes recorded on some detergents to use them properly.

How can you explain this in the light of your study about the properties of enzymes?

Power of hydrogen (pH)

Potential of hydrogen pH is the best measurement determining the concentration of hydrogen ion H^+ in the solution. It also determines whether the liquid is acidic, basic or neutral. Generally, all the liquids of pH below 7 are called acids whereas the liquids of pH above 7 are called bases or alkalines. While the liquids of pH 7 is neutral and it equals the acidity of pure water at 25 C°.

> **Improving the skills**
> Design and do an experiment to show the effect of lowering the temperature of the enzyme (below 0 C°) on its activity.


You can determine pH of any solution using the pH indicators (figure 21).



Figure 21: Relationship of pH with the nature of the solution

pH and the enzymes activity

You know that the enzymes are protein substances. They contain acidic carboxylic groups COOH, and basic amino groups NH_2. So, the enzymes are affected by the changing of pH value.

Each enzyme has a pH value working at it with a maximum efficiency called the optimal pH. If the pH is lower or higher than its optimal pH, the enzyme activity decreased until it stops working. For example, pepsin works at low pH. i.e, it is highly acidic while trypsin works at high pH. i.e, it is basic. Most enzymes work at neutral pH 7.4.

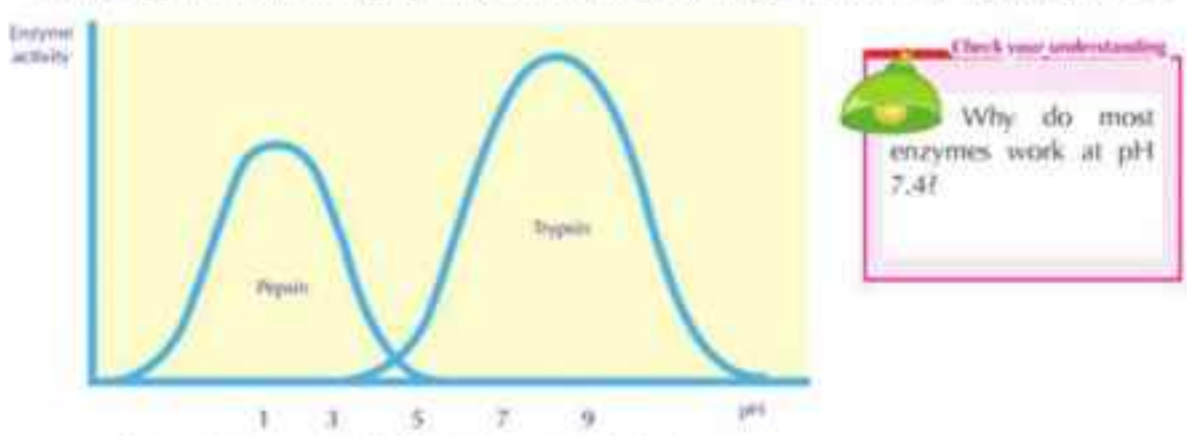


Figure 22: The optimal pH values for pepsin and trypsin enzymes

> **Check your understanding**
> Why do most enzymes work at pH 7.4?

Go Further

For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



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Science, Technology, and Society

Nanobiopharmaceuticals

Proteins have several vital roles in the human body. The ability of proteins to treat a lot of diseases and disorders has been discovered. These biological macromolecules have been known as biopharmaceuticals. Like several medicines, it is extremely difficult to carry on the medicine directly to the target parts or cells in the body. Recently and after the enormous development resulted from the nanotechnology, many trials are conducted to carry on the medicine to the infected cells in the body by using nanoparasites. These trials of carrying on the medicine to the infected cells in the body by using nanoparasites have led to the originating of a new field called nanobiopharmaceutics. As a result, the products used in this field are called nanobiopharmaceuticals.

Key Terms

- **Carbohydrates:** Carbohydrates are biological macromolecules made up of several simple molecules (monosaccharides). They include sugars, starches and fibres. They also are made up of carbon (C), hydrogen (H) and oxygen (O) atoms with the ratio 1:2:1.

- **Lipids**: Lipids are biological macromolecules made up of carbon (C), hydrogen (H) and oxygen (O) atoms. They made up of a large group of heterogeneous compounds. All lipids are insoluble in water and dissolve in nonpolar solvents asbenzene, and carbon tetrachloride

- **Proteins**: are biological macromolecules made basically up of carbon (C), hydrogen (H) , oxygen (O) and nitrogen (N) atoms. They have high molecular weight and their building units are amino acids.

- **Nucleic acids**: Nucleic acids are biological macromolecules. They contain hydrogen, oxygen, nitrogen, carbon and phosphorus. They have two types: RNA and DNA. They are made up of basic units called nucleotides.

- **Metabolism:** Metabolism is a group of biochemical processes occurring inside the cell. During these processes, complex and macromolecules are built up from simple molecules, and some other macromolecules are broken down to release the chemical energy stored in them.

- **Catabolism:** Catabolism is a process in which some macromolecules (carbohydrates, proteins and fats) are broken down into simple molecules to release the chemical energy stored in them.

Concept Chart of Chapter One



Practical activity 

Effect of pH on enzymes activity

Safety precautions



Activity goal

Inferring effect of pH on enzymes activity

Acquired skills

Observing, experimenting, inferring, predicting

Material needed

Amylase solution (5%), starch solution (5%), buffer solutions of different pH values, iodine solution, syringes (5 ml), test tubes, tubes rack, adhesive paper, pipette, stoping watch, and marking pen.

Share your group in this activity.

Amylase catalysis starch into simple sugars. In this experiment, you participate your group colleagues in determining the time taken by the enzyme for completing this process in the presence of a buffer solution which providing the desired pH value during the effect of pH on enzymes activity.

Notice: Buffer solution is that keeps the solution pH value constant at a certain value.

Procedure:

1. Start by using the buffer solution of pH = 7.5 This pH value is the optimal for activity of amylase. Use a syringe to put 2 ml amylase solution in a test tube, then add 1 ml buffer solution and 2ml starch solution, respectively. Carefully mix the tube contents well.
2. In another test tube, put 1 ml buffer solution (pH > 7.5), 2 ml amylase and 2 ml starch.
3. In a third test tube , put 1 ml buffer solution (pH < 7.5), 2 ml amylase and 2 ml starch.
4. Add to each of the three tubes equal number of similar drops of iodine solution. Observe the colouration of tubes with blue.







5. Leave the tubes for a period of time.

Record your observation in the following table:

Test tubes	Contents	pH value	Notes
1	Starch + iodine + amylase	7.5=pH	
2	Starch + iodine + amylase	7.5< pH	
3	Starch + iodine + amylase	7.5> pH	

- In which tube (s), the blue colour was changed? ....
- What is the tube (s) that represents the control experiment? ....
- Why starch is not affected by amylase in other tubes?

....

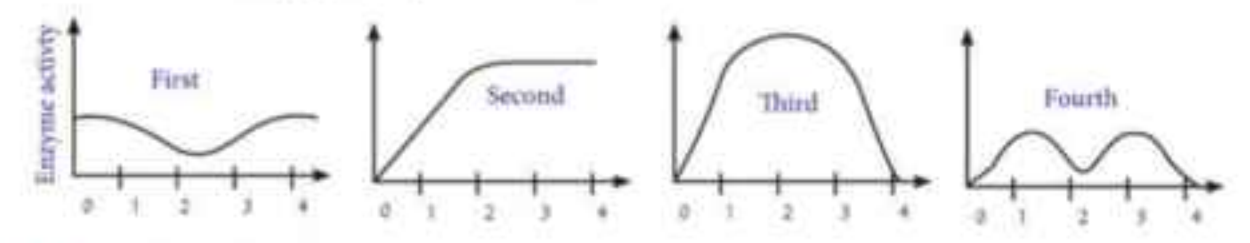
....

- Inffering: In light of your results, show how is enzyme activity affected by pH. ....

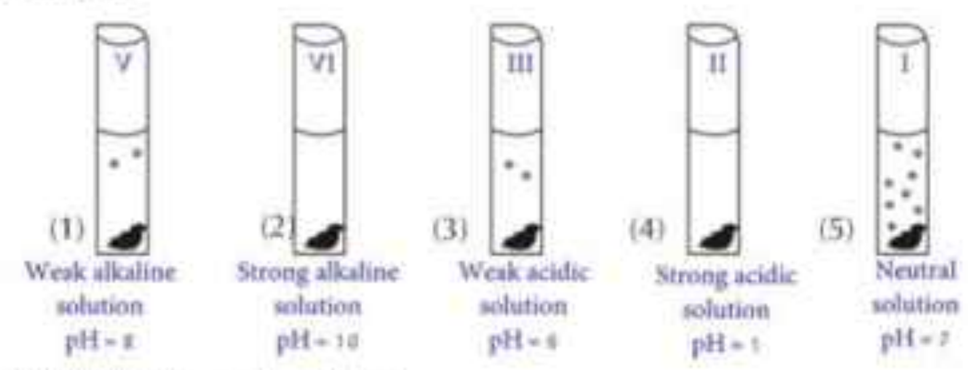
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Assessment activity

1 Stomach secretes pepsin which helps in digestion in the stomach, works well at pH value ranging from 1.5 : 2.5. Which of the following figures shows what will occur to pepsin if pH value in stomach increased?



2 The following figure shows the results of an experiment in which a piece of fresh liver was placed in each of solutions of different pH values after adding of an enzyme.



- What is the name of enzyme? ....

- What is the optimal pH value of enzyme activity? ....
- What is the cause of the choice of a piece of fresh liver in carrying out of this experiment? ....

3 The following table shows the enzymes which work in different regions of the body and the appropriate pH value for each of them. Complete the table, then answer the following questions:

Location of enzyme	Enzyme	pH range	Type of medium
Mouth	Salivery amylase	7.5 - 7	....
Stomach	pepsin	2.5 - 1.5	....
Small intestine	pancreatic amylase, trypsin and lipase	8 - 7.5	....

- Predict the change in salivary amylase activity when it moves from the mouth to stomach. Explain your prediction.Explain ....
- Predict the change in pepsin activity when it moves from the stomach to small intestine. Explain ....

Unit One Exercises

First question: Multiple choice questions:

1 From examples of disaccharides:

A. Glucose B. Fructose C. Galactose D. Sucrose

2 Which of the following is not a polysaccharide?

A. Starch B. Glycogen C. Cellelose D. Sucrose

3 Liquid fats formed by reaction of unsaturated fatty acid with glycerol.

A. Oils B. Fats C. Waxes D. Cholesterol

4 Macromolecules contain hydrogen, oxygen, nitrogen, carbon and phosphorous.

A. Proteins B. Lipids C. Carbohydrates D. Nucleic acids

5 Building blocks of protein.

A. Fatty acids B. Amino acids C. Nucleic acids D. Glucose

6 Which of the following is not monomer?

A. Glucose molecule B. Amino acid C. A nucleotide D. Protein

7. Which of the following is not a function of proteins?

A. Maintainance and transmission of genetic information
B. Controlling the rate of reaction
C. Resistance of diseases
D. Movement of materials inside and outside cells

8. Which of the following statements is correct?

A. Simple sugar is composed of polysaccharide
B. Protein is composed of amino acids
C. Glycerol is composed of fatty acids
D. Nucleotides are composed of nucleic acids

9. How does the enzyme increase the speed of the chemical reaction?

A. By lowering the activation energy
B. By increasing the activation energy
C. By releasing energy
D. By absorbing energy

10. In the chemical reaction, the substrate bind with the enzyme at a region called the:

A. Promotor
B. Resultant
C. Target
D. Active site

11. Which of the following biological molecules is consisted of glycerol and fatty acids?

A. Sugars
B. Starch
C. Lipids
D. Nucleic acids

Second question: Give reasons:

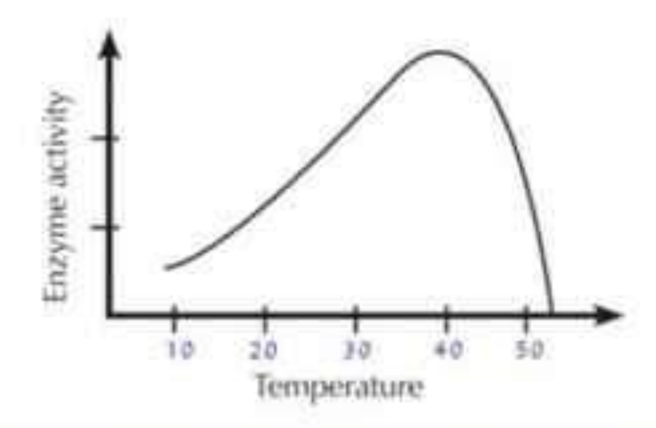
1. The catalysis of protein albumin produces amino acids only.
2. There are millions of protein compounds despite that the number of amino acids is limited.
3. Some animals can maintain their temperature in severly cold places.
4. Sudan-4 stain is used in detecting lipids.
5. Monosaccharides are the responsible for the processes of energy transferring inside cells of living organisms.

Third question: Compare between each of the following:

1. DNA and RNA with respect to pentose sugar and nitrogenous base.
2. Simple and complex sugar with respect to difinitions and give an example.
3. Anabolism and catabolism.

Structural questions:

1. The following figure illustrates the relationship between the activity of an enzyme and temperature:



Temperature at which enzyme activity starts	....
Temperature at which the maximal enzyme activity appears	....
Temperature at which enzyme activity stops	....
The thermal range of enzyme activity.	....

Using results in above table, explain the effect of temperature on enzyme activity.

Unit Two

Cell: Structure and Function

The cell is the basic unit of all life forms. Some living organisms are made up of a single cell, while some others are made up of enormous number of cells. For example, the human body is made up of 10.000.000.000.000 cells. Most cells are extremely tiny to the degree that you can only see them by the microscope.

The cells are specialised to perform certain functions in the plants and animals. For example, at the time you read these words, the nerve cells in your eyes carry messages of what you read to the brain cells and the muscular cells connected to your eyeballs move your eyes across the page.

Cells are collected together to form tissues such as the nerve tissue or muscular tissue. In turn, the different types of tissues form organs such as the eyes, heart and lungs.

All the cells whether they are specialised or unicellular organisms share in general characteristics. The cell respires, feeds, rids of wastes, grows, reproduces (produces similar cells) and finally dies after a certain period of time.

The cells can perform all these functions because they have special structures called cell organelles, where each organelle is specialised for performing a certain function.

For more information about the topic of Cell:structure and function, log in the net.



Time Management

To achieve the maximum benefit of this unit, you need to:

- Manage your time among practical and theoretical study, research and the expansion of information resources.
- Carefully, record the results of your practical study because they are the ideal way to support your learning.

Learning Outcomes

By the end of this unit , the student should be able to:

- Explain how the developing of the microscope contribute to state the cell theory.
- Appreciate the efforts of scientists in discovering the cells and their components.
- Explain the principles of the cell theory.
- Compare the animal and plant cell.
- Draw the accurate structure of the animal and plant cell.
- Examine animal and plant cells microscopically.
- Identify the organelles of the plant and animal cells and the functions of each of them.
- Explain the accurate structure of the cell nucleus and its functions.
- Describe the structure of chromosomes.
- Identify the number of chromosomes in some types of living organisms.
- Explain the ultrastructure of plasma membrane.
- Explain the structure of the cell wall and its function.
- Explain the role of plasma membrane in the process of cellular transport.
- Compare between the prokaryotic and eukaryotic cells.
- Clarify the differentiation of cells into specialized tissues, organs and systems in multicellular animal and plant living organisms.
- Appreciate the grandeur of Allah in the ultrastructure of the cell as a building unit of all living organisms.
- Discard the extremism, fundamentalism, and give up clinging the opinion.
- Follow up the scientific method to solve the problems.

Unit Two

Chapter 1



Cell Theory

By the end of this chapter, you student should be able to:

- Explain the principles of the cell theory.
- Explain the development of the microscopes
- Realize the role of the light and electron microscopes in studying the cell
- Appreciate the efforts of scientists in discovering the cells and their components

key terms

- Cell theory
- Light microscope
- Electron microscope

You know that all living organisms are characterized with common characteristics such as feeding, transferring, respiration, excretion, motion, sensation and reproduction. Some living organisms are unicellular such as bacteria, *Amoeba and Paramecium*, while most of them are multicellular such as humans, whales, and trees.

Diversity of cells

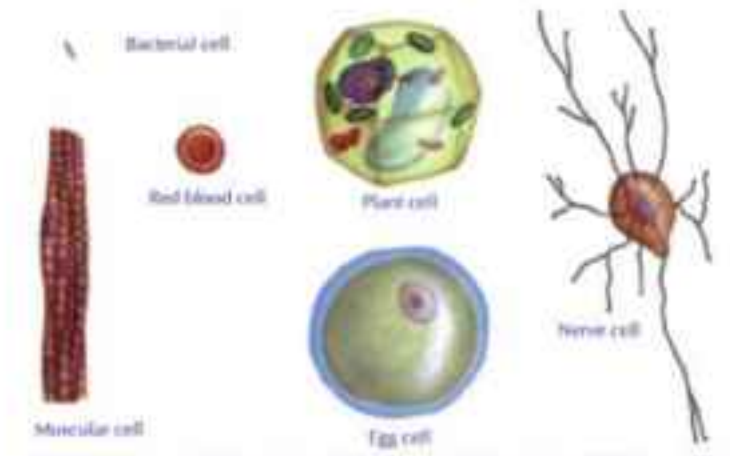


Figure 1: A group of various cells magnified 700 times of their real size.

Cell: The cell is the tiniest building unit in the organism's body capable of carrying out all the functions of life.

Observe the group of cells illustrated in figure 1, then identify:

- What are the differences between these cells in regard to the shape and size?
- Determine which of these cells is the tiniest and which is the biggest.

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• According to your point of view, why cells differ from each other in the shape.

Cells vary in the shape, structure, and size as illustrated in figure (1). There is a relationship between the cell shape and the functions it performs. The nerve cell (neuron) is long to be able to transfer the messages from the spinal cord present inside the vertebral column into your toes. The muscular cells are characterized by being cylindrical and long, and accumulate with each other to form muscle fibres. The muscular cells can contract and relax to help the animal move freely.

Enrichment

Of all the cells, the nerve cell (neuron) is the longest. The length of a nerve cell may reach one meter or a little more, while the biggest cell is the ostrich unfertilised egg.

Cell Theory

From the scientists which have contributed in developing the cell theory are scientists:

Robert Hook

He is an English scientist and has the favour in discovering the cells. In 1665, he invented a simple microscope and used it to screen a piece of cork. He found that the piece is composed of small boxes, figure 2. He named each box the word cell. The term cell is derived from the Latin word cellula which means the cell or the small room.

Antonie Van Leeuwenhoek

Antonie Van Leeuwenhoek was born in Netherlands in 1932. He spent his life as a government employee. Van Leeuwenhoek was amateur to screen objects using the lenses. By using these lenses, Van Leeuwenhoek succeeded in making a simple microscope with ability to magnify the objects up to 200 times of their real size. He used this microscope for screening different substances such as water of ponds, and blood. Van Leeuwenhoek was the first human being to observe the world of microscopic organisms and living cells.



Figure 2: The draw which Robert Hook demonstrated for the cork tissue in the form of rows of sequenced spaces as he screened throughout the microscope.



Figure 3: Antonie Van Leeuwenhoek's microscope

Matthias Schleiden

In 1838, the German scientist Matthais Schleiden deduced that all the plants are composed of cells. He stated his conclusion depending on his own researches and that of the other previous scientists.

Theodor Schwann

In 1839, the German scientist Theodor Schwann deduced that all living organisms bodies are composed of cells.

Rudolf Virchow

Rudolf Virchow is a German doctor. In 1855, he stated that the cell is the functional and building unit of all living organisms. Additionally, he emphasized that the new cells are produced only by previous other living cells.

Develop your skills

Summarizing skill:

Brief the role of scientists: Robert Hook, Antonie Van Leeuwenhoek, Matthais Schleiden, Theodor Schwann and Rudolf Virchow in discovering the cells.

The efforts of previous scientists have resulted in and gave rise to what is known by the cell theory. The cell theory is considered the most important basic theory in the modern biology. This cell theory is mainly based upon the following three principles:

1. All living organisms are made up of cells.
2. Cells are the basic functional units for all the living organisms.
3. All cells come only from other pre-existing living cells.

Development of Microscopes

The progression of biology is thoroughly based upon the development of the technologies used in the science field related to the cell science (Cytology). This development has leaded to increase the ability of scientists to observe and analyse. Among of all the technologies, the microscope was the most important tool.

Light Microscope

The light microscope was the only available tool for the scientists until 1950. This microscope depends on the sunlight or artificial light to work. It is characterized with its ability to magnify micro - organisms and nonliving things. It is also used for screening the composition of large sized objects by slicing them into thin slices that allow the light to permeate through. The light microscope could magnify the objects 1500 times of their actual size according to the magnifying power of the two lenses used (objective and ocular lenses). These lenses are made of glass and they can not magnify more than 1500 times because the image will be blurred (unclear).

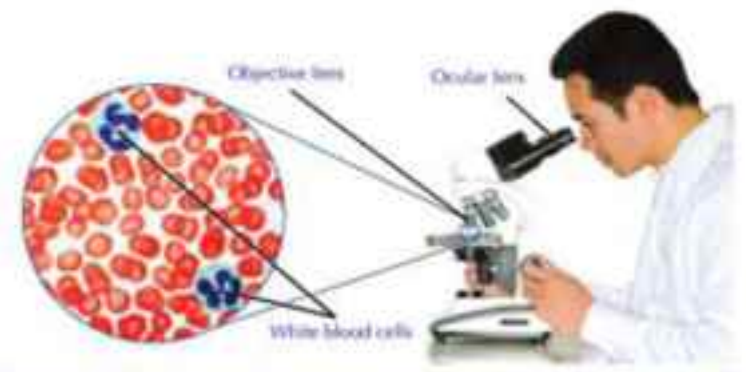


Figure 4: White blood cells as seen by a compound light microscope. The image is magnified 1000 times its actual size.

The total magnifying power of the light microscope can be calculated through the following relation:

Magnification = the magnifying power of ocular lens × the magnifying power of the objective lens.

Over years, scientists innovated better methods to observe the samples more clearly throughout increasing the contrast (difference) between the different parts of the sample. One method of these contrast methods between the sample parts was using the dyes to stain or colour certain parts of the sample to be clearer. Similarly when we screen the white blood cells as illustrated in (figure 4). On the contrary, using the dyes involve disadvantages such as they kill the living samples. There is another method to increase the contrast which is done by changing the level of light.

✲ Observe: How does the contrast between the three images in figure 5 seem? Compare them.

Electron Microscope

In 1950, scientists started to use the electron microscope in which a beam of electrons with high-speed is used instead of light. These electrons are controlled by electromagnetic lenses. Objects can be magnified 1000.000 times of their actual sizes.

The electron microscope provided a field to clarify the cellular components that had not been known before. It helps to know more accurate details for the structures that had been known before because the electron microscopes provide high resolution magnified, and highly contrasted images comparatively to those produced by light microscopes. It is related to the shortness of the wavelength of the electronic ray comparatively to the light ray. Objects' images are

Life Skills

Communication Skills

Use the references in school library or the internet to write down a report about electron microscopes. Review your report with your teacher then display it in front of your classmates to discuss it.

received on a fluorescent screen or on a highly sensitive photographing board.

There are two types of electron microscopes: the scanning electron microscope used for studying the cell surface, and transmission electron microscope used for studying the internal structures of the cells.

* **Observe** the image of the white blood cell under the two types of the electron microscopes-scanning and transmission.



Figure 5 : A white blood cell as it appears under the scanning electronic microscope (magnifying power used × 3500) and as it appears under the transmission electron microscope (magnifying power used ×8900). Compare the tow images in the two cases..

• Thus, you can see that the development of microscopes increases our knowledge of the science of cell (Cytology) and its related sciences.

Activites and Excersises

Chapter 1 Cell theory

Practical activity 

Ideal using of the compound microscope

Safety precautions



Activity goal

Using a compound microscope correctly for examining some fine details that can not be seen by naked eye.

Acquired skills

Using scientific devices , observing, comparing, recording and analyzing data.

Materials needed

An onion , glass slide, coverslip, forceps, compound microscope, scalpel , dropper, blotter, iodine solution

You will use the compound microscope in several activities. You can use it correctly in this activity.

Procedure:

1. Cut the onion into 4 pieces.
2. Using forceps , separate a part of the thin transparent membrane lining the concave surface of one of the pieces. Put it on a water drop placed at the middle of a glass slide, then cover it with a coverslip.
3. Examine using the low power objective lens, then the high power one of the microscope. Observe the most superficial layer of cells.
4. Use a blotter to remove excess water then add a drop of iodine at an edge of the coverslip. Iodine will diffuse throughout the specimen
5. Re-examine the specimen using the low, then high power objective lens of microscope. Observe the difference.







Observation and data recording and analyzing

1. **Observe :** How many cells that you could see using low power objective lens of microscope? ....
2. **Observe** : How many cells that you can see using the high power objective lens? ....
3. **Observe** : How did onion cells appear using iodine solution instead of water? ....

Conclusion:

1. Why is the microscope used? ....
2. How can microscope be used correctly? ....

Unit Two

Chapter 2

Cell Ultrastructure

By the end of this chapter, you should be able to:

- Identify the organelles of plant and animal cell and the functions of each.
- Explain the ultrastructure of the cell nucleus and its functions.
- Describe the structure of the chromosome.
- Explain the ultrastructure of the plasma membrane.
- Explain the structure of the cell wall and its function.
- Appreciate the grandeur of Allah in the accurate structure of the cell as a building unit of living organisms.
- Design a model for the eukaryotic cell.
- Compare between the eukaryotic and prokaryotic cells
- Compare between the plant and animal cells
- Examine the plant and animal cells microscopically.
- Draw the ultructure of the plant and animal cells.

key terms

- Cell membrane
- Cell wall
- Cytoplasm
- Nucleus
- Cell organelles
- Chromosome
- Endoplasmic reticulum
- Golgi body
- Lysosome
- Mitochondria
- Centrosome
- Chloroplasts
- Ribosomes
- Prokaryotic cell
- Eukaryotic cell

You have learned that the cell is the functional and building unit in all living organisms. These cells are characterized by their ability to grow, reproduce, respond to external stimuli and perform the different metabolic processes.

Think

- How can a cell perform all these functions?
- What are the structures present in the cell that enable it to perform these functions?

Cell Parts

The cell is basically made up of a protoplasmic mass surrounded by the cell membrane. The protoplasm is differentiated into a nucleus and cytoplasm. Cytoplasm contains a group of cellular structures called cell organelles.

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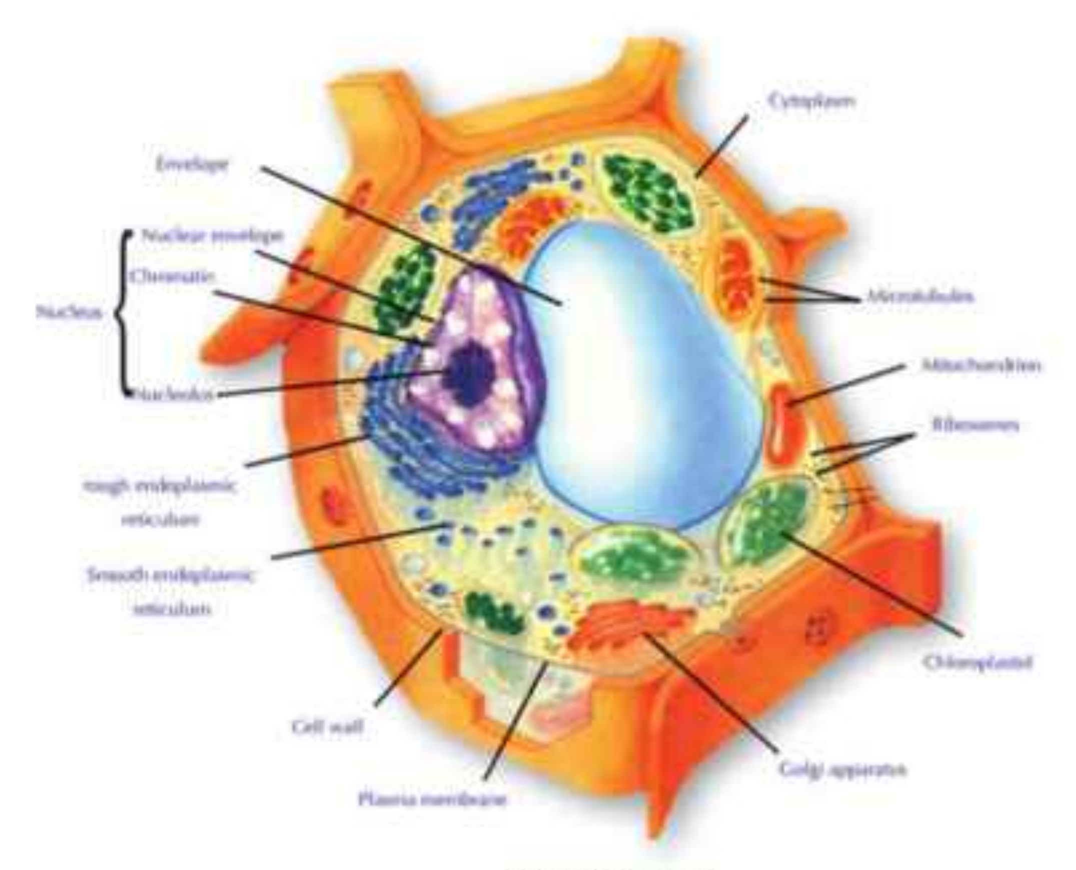


Figure (6): Plant cell

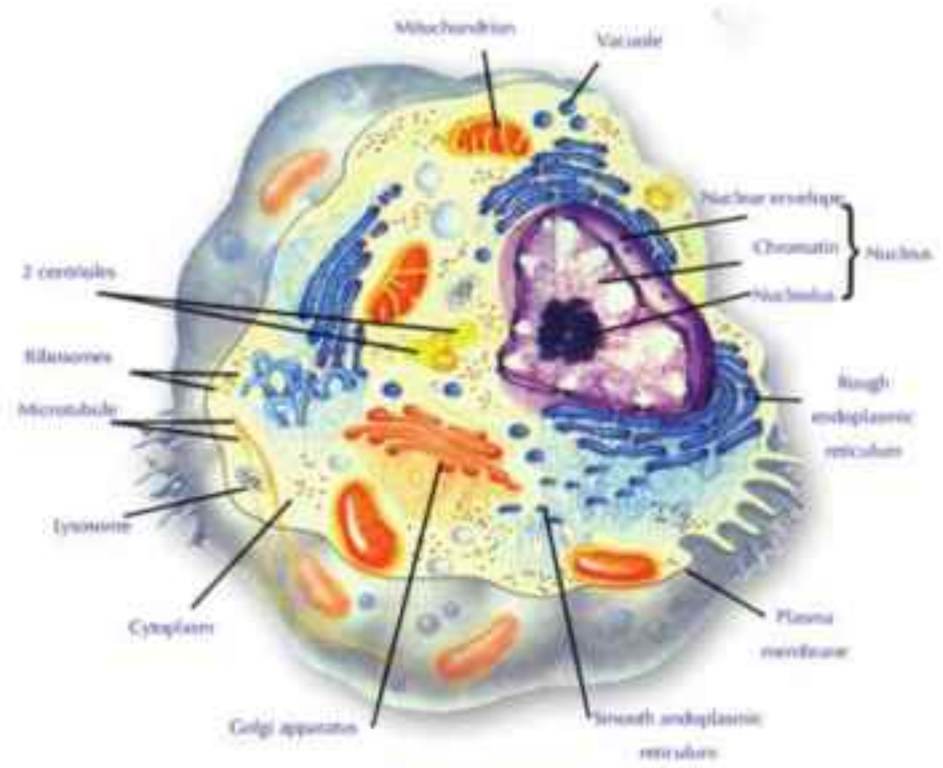


Figure (7): Animal cell

First: Cell wall

Cells of plants, algae, fungi and some bacteria are surrounded by a cell wall besides the cell membrane. This wall provides the cells with support and protection. Cell wall is characterized with being pitted. It is mainly composed of cellulose fibers, therefore this wall allows the passage of water and dissolved substances through it easily.

Enrichment

Cell walls play an important role in protecting the cells and making them resistant to wind and other weather factors. These walls provide the cells with strong support as in the perennial trees such as palm trees. While herbal small plants contain cell walls with little elasticity that make them able to maintain their shapes as they are exposed to strong wind.

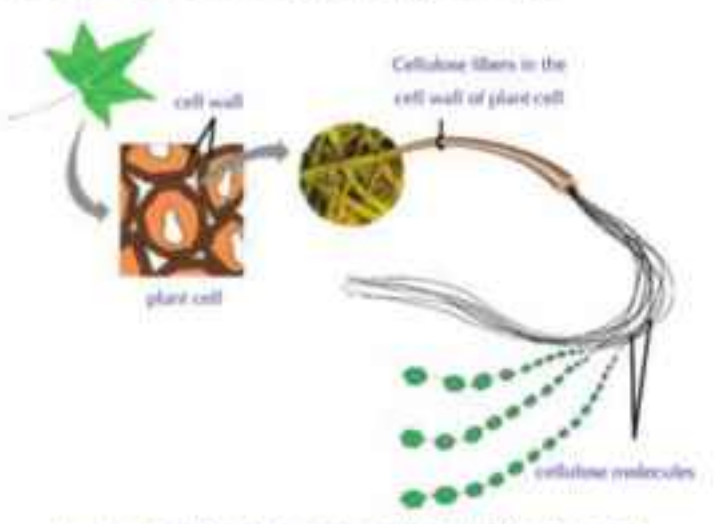


Figure 8: Cellulose fibers in the cell wall of the plant cell

Second: Cell membrane(plasma membrane)

It is a thin membrane covering the cell and separates its components and surrounding medium. This membrane performs a basic role in organising the passage of substances to and from the cell. Besides, it prevents the spreading of cytoplasm outside the cell.



Go Further

For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



Cell membrane is composed of two layers of phospholipids molecules which their hydrophilic heads (dissolve easily in water) meet the water medium in and out the cell. While their hydrophobic tails (do not dissolve) are present inside the membrane, figures 9 and 10.

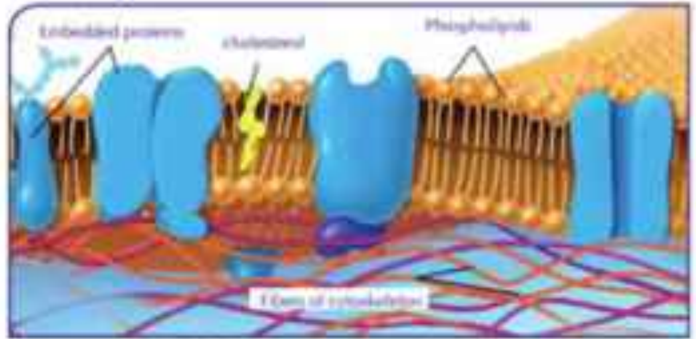


Figure 9: The structure of a cell membrane

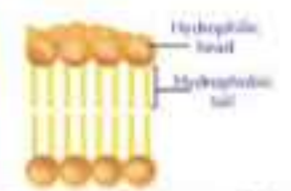


Figure 10: The structure of the phospholipids molecule and how phospholipids molecules are arranged in the cell membrane

Molecules of proteins are embedded between molecules of these two layers. Some of these protein molecules work as cell identification sites to different substances such as nutrients and hormones. While some others work as gates to pass the substances to and from the cell.

Due to the phospholipids forming the cell membrane are a fluid substance, the membrane in turn is considered a fluid structure (similar to the oil floating on water surface). The linkage of phospholipids molecules with molecules of cholesterol contributes maintaining the cell membrane cohesive and intact.

Third: Nucleus

The nucleus is the most obvious organelle in the cell that you can see under the microscope. It often has a spherical or oval shape and located in the middle of the cell. Furthermore, it is surrounded by a double membrane called the nuclear envelope. The nuclear envelope separates the contents of the nucleus from cytoplasm. There are several tiny pores in the nuclear envelope through which the substances pass between the nucleus and the cytoplasm.

The nucleus contains a transparent gelatinous fluid called nucleoplasm. The nucleoplasm contains minute tangled threads coiled around themselves and called chromatin. The nucleus also contains another structure called nucleolus (Figure 11). The cell nucleus may contain more than a nucleolus, especially in the cells responsible for forming and producing the protein substances such as enzymes, hormones and so on.

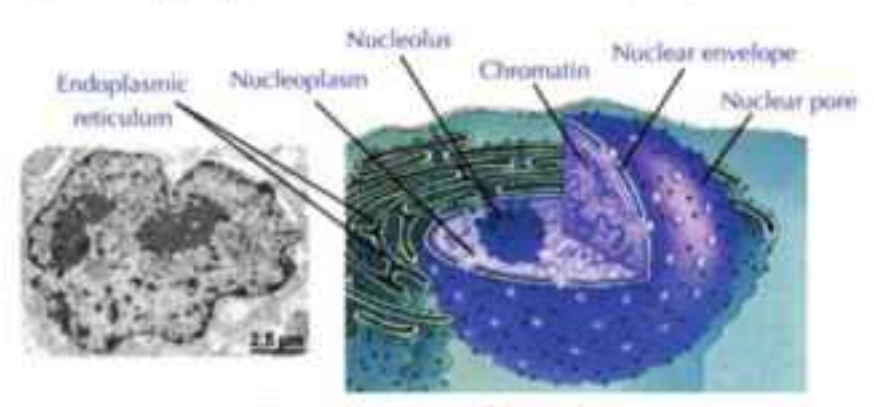


Figure 11: Structure of the nucleus

Structure of chromosomes

During cell division, chromatin gets changed into rod-like structures called chromosomes, figure 12. Chromosome appears in the metaphase of the cell division consists of two threads joined together at a central part called centromere. Each thread of those two threads is called chromatid, figure 13. Each chromatid is composed of nucleic



Figure 12: Behaviour of chromosomes during cell division

acid DNA coiled around molecules of proteins called histone. DNA carries the genetic information that controls the shape and structure of the cell and organises the vital activities of the living organism cells. All your body traits are inherited from your ancestors and you inherited them throughout transferring copies of the stored genetic material which is being copied to the new generations during reproduction.

Word meaning

Chromosomes were given this name because they are stained by the basic dyes and take a coloured stain that makes them more clearly seen during cell division.

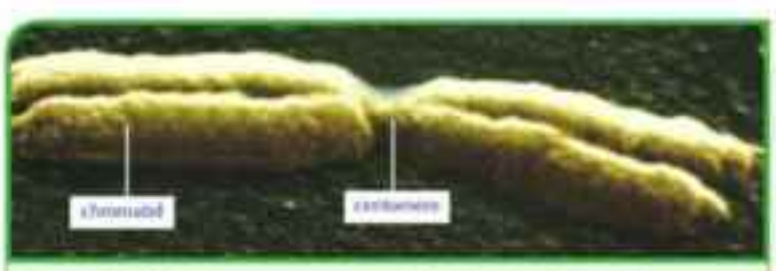


Figure (13): Chromosome as appeared under the electron microscope during cell division

Do you know?

Chromosome is not consisted of 2 chromatids in all phases of mitosis except at its beginning till its metaphase. It becomes consisted of one chromatid in anaphase and telophase, and called daughter chromosome. At the beginning of each new division, the genetic material is duplicated, so each chromosome consists of 2 chromatids..

Fourth: Cytoplasm

The cytoplasm is almost a fluid-like substance present between the cell membrane and nucleus. It is mainly composed of water and some organic and inorganic substances. It also contains a network of threads and microtubules that acquire the cell a support to help it maintain its shape and form. In addition to its work as passages to transfer the different substances from one place to another inside the cell and is called the cytoskeleton. The cytoplasm also contains a group of various structures known as cell organelles. Some of these organelles are not surrounded by a membrane and called non-membranous organelles such as ribosomes and centrosome. While some other organelles are surrounded by a membrane and called membranous organelles such as endoplasmic reticulum, Golgi apparatus, mitochondria, lysosomes, vacuoles, and plastids.



Ribosomes

Ribosomes are round-shaped organelles that synthesize protein in the cell. Some of them are present in the cytoplasm (single or in clusters) where the protein is produced and directly released in the cytoplasm. The cell uses it in its vital processes such as growth, regeneration, and so on. While most ribosomes are attached to the outer surface of the endoplasmic reticulum and produce the proteins transferred by endoplasmic reticulum to the outside of the cell (such as enzymes) after entering some changes to it.



Centrosome

Animal and some fungi cells (except for nerve cells-neurons) contain two tiny particles called centrioles. They are located near the nucleus in a region of the cytoplasm. This region is called centrosome.

The centrosome is not present in the plant and some fungi cells. These cells contain a region of cytoplasm to conduct the same functions instead. Each centriole is composed of nine groups of microtubules ordered in triples in a spherical shape, figure 14.



Figure (14): Centrioles

The centrosome plays an important role during cell division where the spindle filaments extend between the centrioles present at each pole of the cell. The centrosome also plays an important role in forming the flagella and cilia.



Endoplasmic reticulum:

The endoplasmic reticulum is a network of membranous canaliculi that extends in all cytoplasm. It is attached to the nuclear envelope and cell membrane. So it forms an internal transferring system that benefits in transferring the substances from a part to another inside the cell and so transferring the substances between the nucleus and the cytoplasm.

Thinking corner

The presence of smooth endoplasmic reticulum increases in heptic cells. While, the presence of rough endoplasmic reticulum increases in cells of stomach linig and endocrine glands. Explain this in the light of your study of endoplasmic reticulum functions.

✲ There are two types of the endoplasmic reticulum

There is a rough endoplasmic reticulum and smooth endoplasmic reticulum. The rough endoplasmic reticulum is characterized by the presence of a large number of ribosomes on its surfaces. It is specialized in synthesising proteins in the cell, making changes on the protein produced by the ribosomes, and making new membranes in the cell. As for the smooth endoplasmic reticulum, the ribosomes are absent from it. It is specialized in synthesising lipids, transforming glucose into glycogen, and modifying the nature of some toxic chemicals in the cell to reduce its harmful effects.



4 Golgi apparatus

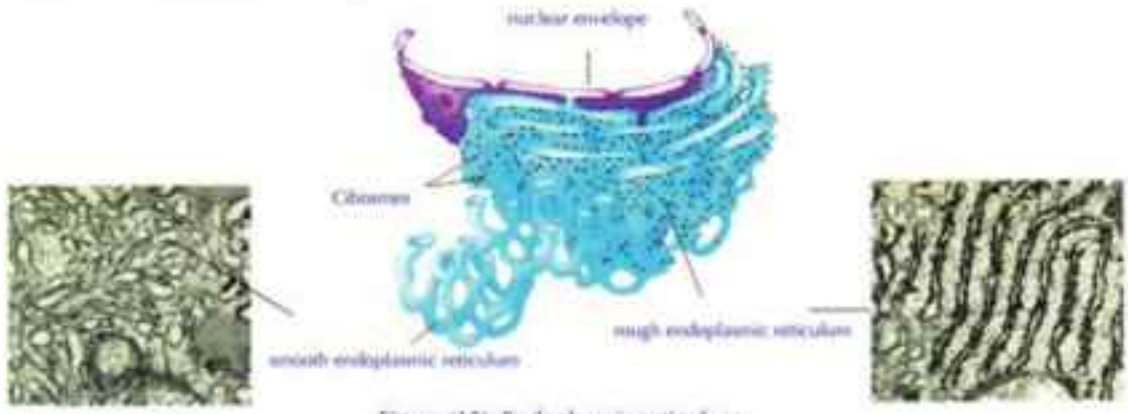


Figure (15): Endoplasmic reticulum.

Golgi apparatus is a series of flat membrane-bound sacs. The numbers of Golgi apparatus differ in the cell according to the cell's secretion activity. Golgi apparatus is specialised for receiving the molecules of substances secreted by the endoplasmic reticulum across a group of transporting vesicles. Then, it classifies and modifies these vesicles and distributes them into the places where they are used in the cell. Golgi apparatus may also pack them inside secreting vesicles called lysosomes, that move forward to the cell membrane as the cell dismisses it to outside as secretory products.

Word origin

Golgi apparatus is named for its discoverer,Italian anatomist and pathologist Camillo Golgi who described it for the first time in 1898. This organelle is also known as Golgi complex or Golgi apparatus. It is also known as dictyosomes in plants and algae.

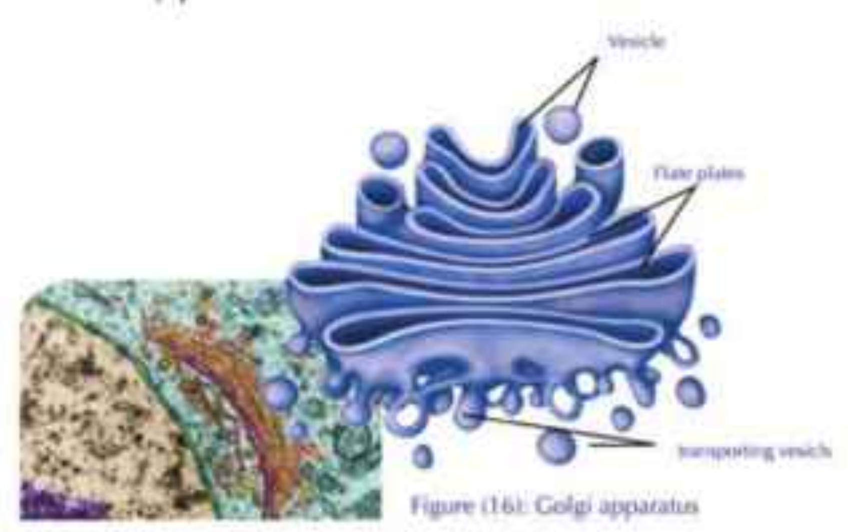


Figure (16): Golgi apparatus

 Lysosomes

Lysosomes are small, round, membranous vesicles formed by Golgi bodies. They contain a group of digestive enzymes. Lysosomes' function is to rid of worn and senile cells and organelles which no longer have benefits. Furthermore, lysosomes digest the large molecules of nutrients engulfed by the cell and change them into structurally simpler substances to enable the cell to benefit from them. For example, white blood cells use the digestive enzymes present inside the lysosomes to digest and destroy the pathogens which invade the cell, figure 17.

The cell is not affected by the lysosome enzymes because these enzymes are surrounded by a membrane isolating them from the cell components.

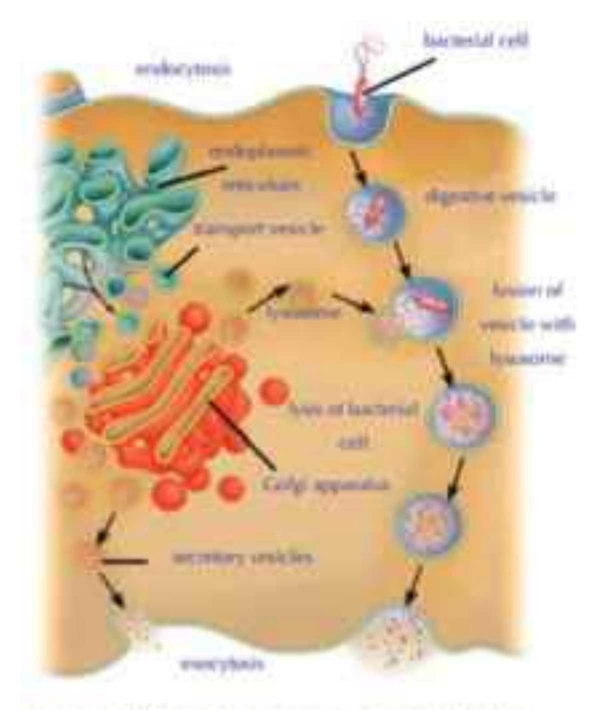


Figure (17): The role of lysosomes in digesting the pathogens inside white blood cells

 Mitochondria

Go Further

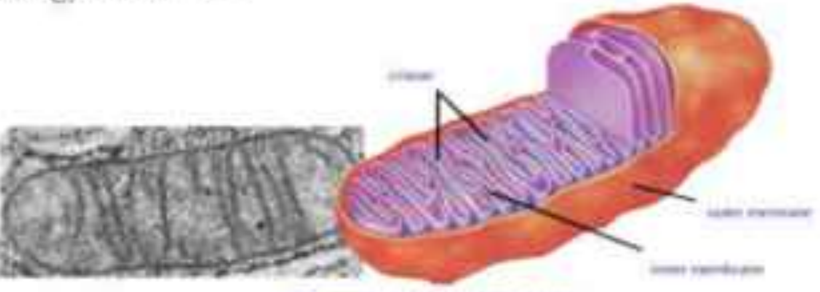
For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



Mitochondria are sac-like membranous organelles. Its wall consists of two membranes. A group of folds known as cristae extends from the inner membrane into its matrix figure 18. These cristae work on increasing the surface on which the chemical reactions producing the energy take place. Mitochondria are considered the main storehouse for the respiratory enzymes in the cell. They are also considered a storehouse for other substances necessary to store energy resulting from respiration (due to the oxidation of the nutrients, especially glucose). The energy resulting from respiration is stored in the form of a chemical compound called adenosine triphosphate (ATP) from which the cell can extract energy once more.

Thinking cornerner

Imagine that the inner membrane of mitochondria does not contain cristae. Does the efficiency of mitochondria increase or decrease? Explain.


Figure (18): Mitochondrion

7 Vacuoles

The vacuoles are sac-like membranous sacs (similar to bubbles filled with a liquid). They store water, nutrients, and the wastes of the cell until it gets rid of such wastes. The vacuoles are small and large in number in animal cells while they are collected in one big vacuole or more in the plant cells.

8 Plastids

The plastids are various shaped membranous organelles present in plant cells only. There are three types of plastids that differ from each other in regard to the pigment present in each type:

- **White plastids or Leucoplasts**: They are plastids that don't contain any type of pigments. They work as centers for storing starches. Furthermore, they can be present in the roots of sweet potatoes, stems of potatoes and the internal leaves of cabbage.

- **Chromoplasts**: They are plastids that contain carotenoids which their colours varies between red, yellow and orange. This type extensively spread in the petals of flowers, fruits and in the roots of some plants such as rapeseed

- **Chloroplasts**: They are present in the leaves and stems of green plants. They contain the chlorophyll that transforms the light energy of the sun into chemical energy in the form of glucose throughout photosynthesis. Chloroplasts are composed of a double envelope surrounds a matrix called the stroma. The stroma contains layers of disc-shaped, compact structures known as thylakoids which each group of them forms what's known by granum. (figure 19).

Enrichment

The colours of the plant cell are related to the chromoplasts as in the petals of the flowers or the presence of some coloured pigments in cytoplasm as in beet and roselle

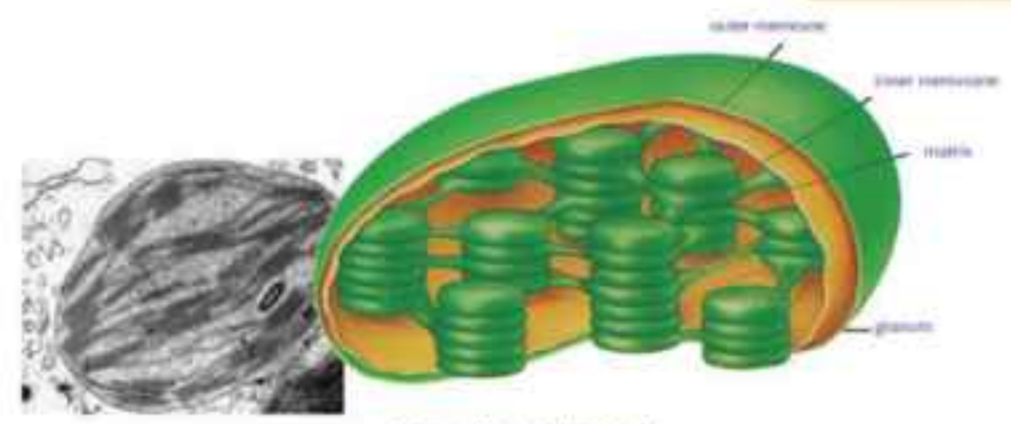


Figure (19): A chloroplast

Go Further

For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



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Practical activity 

comparing plant and animal cells

Safety precautions



Activity goal

Comparing the plant and animal cells.

Acquired skills

Working in a team, observing , scientific drawing , recording and analyzing data, Concluding ,designing experiments.

Materials needed

Glass slides, Elodea plant leaves, forceps , dropper, water , prepared slide of human check cells, compound light microscope .

Cooperate with your colleagues in the group to perform this activity and discuss them about the observation the have reached. Explain and compare the results with that of 2 other groups. Participate in expressing an opinion during the group discussion that occur under the supervision and guidance of your teacher .

Procedure:

1. Use forceps to separate a young leaf from the tip of *Elodea* plant and put it on a drop of water places on a glass slide. Cover with a coverslip.
2. Examine the leaf by the low power objective lens (4x) of the microscope, then by the medium power one (10x). Observe the superficial layer of leaf cells .
3. Draw some cells you saw. Label its different structures .
4. Examine the specimen using the high power objective lens (40x). What are the cellular structures you observed now? Draw these structures inside the cells that have already drawn and label them .

5. Repeat the steps (2-4) with the prepared slide of human check cells.

➡ Observing and diagrammatic drawing:

Plant cell	Animal cell

Recording and analyzing data:

1. Record the common and different structures you observed in both the cell of *Elodea* plant and the cell of human's check in the following table:

Elodea plant cell	Human's check cell	Common structures of both cells
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....

2. What is the cause of plant leaf colouration by green colour?

....

....

3. How can you make the structures observed in the plant leaf cells more visible?

....

....

4. What are the organelles you expected to see , but did not appear at examination? Explain the reason.

....

....

Conclusion:

What do you conclude from this activity?

....

....

Applied activity 

Designing a model of cell membrane

Safety precautions



Activity goal

Designing a model illustrates cell membrane

Activity skills

Observing , analogy, concluding

Materials needed

Glass dish, vegetable oil, water , and fine sawdust.





Procedure:

1. Bring a water filled glass dish .
2. Add a suitable amount of vegetable oil till cover water surface .
3. Disperse a little of the fine sawdust on the oil layer surface.



Observation and data recording and analyzing:

1. **Observe** : What will happen to oil after pouring it on water surface? ____________

____

2. **Observe** : What will happen to sawdust after its dispersing on oil surface?. ____

____

3. **Analogy** : Whow what each of water , oil , and sawdust represents in structure of cell membrane?

____

____

Conclusion:

What do you conclude from this activity?

____

____

Applied activity  **Designing a model for the chromosome**

Safety precautions



Activity goal

Designing a model for the chromosome using environmental materials

Acquired skills

Designing , Innoving , working in a team

Materials needed

Isolated electric wire , disk-shaped magnetic pieces, pincers, and metallic stalk

Procedure:

1. Use the pincers to cut the electric wire into equal pieces (about 30 cm each) .





2. Roll the wire around the metallic stalk to get a spiral - shaped wire.

3. Fix the metallic wire upon the disc-shaped magnetic pieces.

- What does each spiral piece of wire represent? ....
- What does the magnetic piece represent? ....

4. What is the difference between the 2 figures (A) and (B):

- (A) ....
- (B) ....
- Are the chromosomes equal in size? ....



(A)



(B)

5. Design another activity shows the chromosomes using wood or cardboard as in the opposite figure

- Are the chromosomes equal in size? ....



- What does it mean having a heterozygous pair of chromosomes in the opposite figure? ....
- What do you conclude from this activity? ....

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Assessment activity

1. Study the following figure, then answer the following questions:

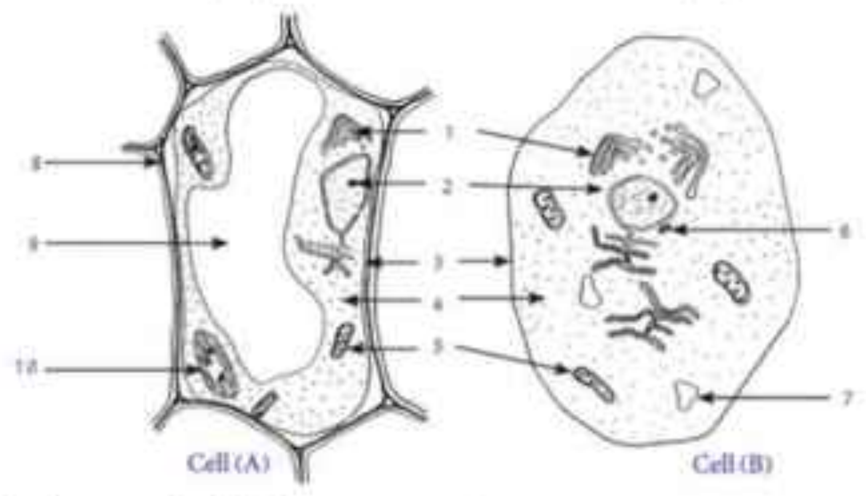


- The figure illustrates the structure of ....
- Write down the name of numbered parts:
  1: ....
  2: ....
- What is the function of this organelle? ....

....

....

2. Examine the following figures, then answer the following questions:



- Specify the type of cells? A : .... , B: ....:
- Name the following numbered parts:

1: .... , 2: .... , 3: .... , 4: ....

5: .... , 6: .... , 7: .... , 8: ....

9: .... , 10: ....

- What do you expect to happen when the organelle no. 2 is removed from the cell ? Explain.

....

....

3 In light of the study of the distinguishing characteristics of both prokaryotic and eukaryotic cells: in front of you a picture of a microorganism that live in the human alimentary canal . Specify the type of the cell of this organism , prokaryotic or eukaryotic ? Explain.

....

....

....

4 The following table shows some information about three different cells. Determine whether each cell is prokaryotic or eukaryotic. If any of them is eukaryotic, determine whether it is plant or animal cell. Give an explanation for the decision taken in each case, with each cell.

The structure	cell (A)	cell (B)	cell (C)
Cell wall	present	present	not present
Cell membrane	present	present	present
Chloroplastids	present	not present	not present
Mitochondria	present	not present	present
Nucleus	present	not present	present

- Cell (A) type: ....
- Cell (B) type: ....
- Cell (C) type: ....
- The explanation: ....

....

Unit Two

Chapter 3

Differentiation of Cells and Diversity of Plant and Animal Tissues

By the end of this chapter, you should be able to:

- Identify the organization levels in the multicellular living organisms.
- Identify the concept of tissue.
- Differentiate between the simple and complex tissues.
- Identify different types of animal and plant tissues.
- Determine the functions of the tissues.

Key terms

- Simple tissue
- Compound tissue
- Parenchyma
- Collenchyma
- Sclerenchyma
- Xylem
- Phloem
- Epithelial tissue
- Connective tissue
- Muscular tissue
- Nervous tissue

Most living organisms are composed of several cells. But, are these cells irregular or disordered? Does each of them work separately from the other?

Organization of Living Organisms

Cells are specialized in their functions, so they are present in types but not one. Each group of specialized cells organize to form what is known as a tissue. For example, the heart muscular cells which organize with each other to form the muscular tissue of the heart wall, figure:20.


Figure (20): Muscular tissue in heart wall


Figure (21): Heart


Figure (22): Circulatory system

If the cells forming the tissue were symmetrical with each others in the shape, structure, and function, then the tissue is called a simple tissue.

But, if the tissue is composed of more than a type of cells, then it is called a compound tissue. Types of tissues vary and contrast in regard to the difference and diversity of living organisms and so are the activities and the vital functions conducted by the tissues. We will

identify the most common types of tissues in animals and plants in the following. In most living organisms the tissues organize with each other in groups called organs. Each organ is a group of tissues working harmonly to perform certain functions. Such tissues and organs are present in plants and animals. For example, the heart, figure 21, is an organ in the multicellular organisms such as humans. It is mainly composed of a heart muscular tissue, nervse, and connective tissue. Heart muscles, nerves and connective tissue collaborate together in their work to pump the blood from the heart to all body parts.

The group of organs working together form what is known as the system. The heart, blood and blood vessles form the circulatory system of humans, figure 22. Systems organise and integrate together to form the whole body of the organism. The human body is composed of the integration of several systems besides the circulatory system such as skeletal system, muscular system, nervous system, digestive system, respiratory system, excretory system , reproductive system and so on.

Plant Tissues

Plant tissues vary into simple and compound tissues.

First: Simple tissues

There are three types of simple tissues:

Parenchyma tissue: The cells of parenchyma tissues are oval or round shaped. Their walls are soft and elastic and contain spaces among them for aeration. The parenchyma tissue contains chloroplasts, chromoplasts, or leucoplasts.

Parenchyma cell contains one big vacuole or more filled with water and mineral salts. The parenchyma tissue performs several functions such as photosynthesis, storing nutrients such as starch, and it is responsible for aeration.

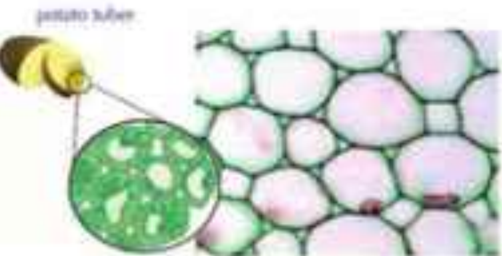


Figure (23): Parenchyma tissue

Collenchyma tissue: The collenchyma tissue is a soft tissue. It is a living tissue and its cells are somewhat rectangular-shaped cells. Its walls are irregularly thickened with cellulose. This tissue helps in supporting the plants by acquiring them the elasticity needed

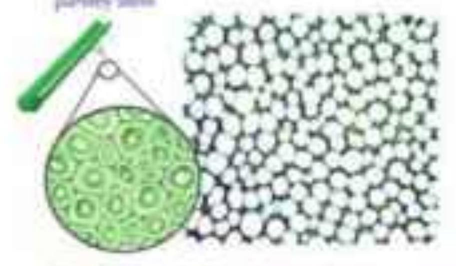


Figure (24): Collenchyma tissue

Sclerenchyma tissue: The sclerenchyma tissue is a solid tissue. It is a non-living tissue. The cells of these tissues are thickened by a substance called lignin, in addition to cellulose. It also strengthen and support the plants and acquiring them the elasticity and hardness needed.

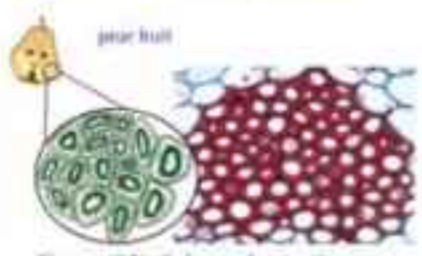


Figure (25): Sclerenchyma tissue



Go Further

For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



Second-Complex tissues

Examples of complex tissues in the plants are vascular tissues the conductive tissue. They are divided into two types; xylem and phloem. Their function is the transport (conduct) in the plants.

Xylem tissue



- The following link in the Egyptian Knowledge Bank (EKB) illustrate the structure and function of Xylem tissue

Phloem tissue



- The following link in the Egyptian Knowledge Bank (EKB) illustrate the structure and function of Phloem tissue

Animal Tissues

Animal tissues can be differentiated into four basic types. Each of them matches with the function it performs:

First: Epithelial tissues: They are the tissues that cover the outer surface of the body or line-up the body's internal cavities. The epithelial tissue is composed of a great number of closely adjacent cells connected by little interstitial substance

The epithelial tissues are subdivided into two basic types with respect to the shape and structure:



1 Simple epithelial tissue:

Its cells are organized in one layer, figure 26, the example of this tissue are:

Simple squamous tissue : It is composed of one layer of flattend cells as in the endothelium of blood capillaries and the walls the alveoli in the lungs.

Simple cuboidal tissue: It is composed of one layer of cuboidal cells as in the lining of kidneys' tubules.

Simple columnar tissue: It is composed of one layer of columnar cells as in the lining of the stomach and the intestines.

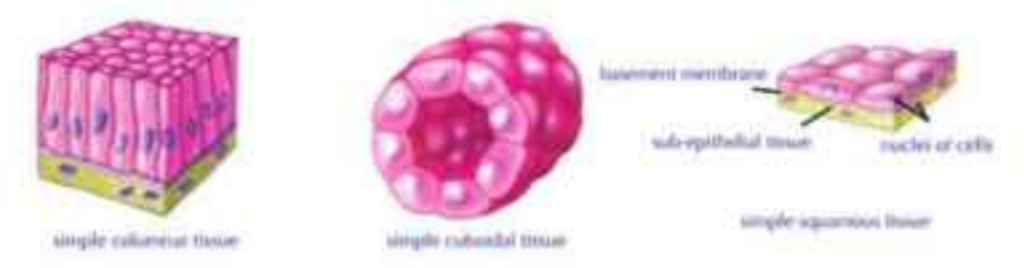


Figure (26): Examples of simple epithelial tissues

 Stratified or compound epithelial tissue:


Figure (27): startified squamous tissue

Its cells are organized in several layers, figure 27, its examples are:

Stratified squamous tissue: It is made up of several layers of compact cells above each others. The surface layer of this tissue is squamous as in the skin epidermis.

The epithelial tissue performs different functions with respect to its site such as:

- Absorbs water and digested food as in the lining of the digestive canal.
- Protects the cells which it covers from drought and pathogens as in the skin epidermis.
- Secretes the mucus that makes the cavities it covers smooth as in the digestive canal and the trachea.

Second: Connective tissues

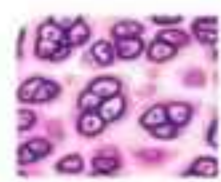
The connective tissues are made up of somewhat distant cells that immersed in an intercellular substance that may be fluid, semi-solid, or solid (figure 28). Accordingly, they are divided into three groups:

1. **Connective tissue proper :** It is the most widely spread type. It gathers between being fairly solid and quite elastic. The main function of this tissue is to bind the different tissues and systems of the body with each other. This type is present under the skin and in the mesentries.

2. **Skeletal connective tissue:** It includes the bones and cartilages. It contains a solid intercellular substance in which calcium precipitates in case of the bones. Its basic function is the supporting of the body.

3. **Vascular connective tissue :** It includes the blood and lymph. It contains a fliud intercellular substance. Its basic function is to transport digested food and excretory substances.


Vascular connective tissue (blood)


Skeletal connective tissue (cartilage)


Skeletal connective tissue (bone)


Connective tissue proper

Figure (28): Examples of connective tissues

Third: Muscular tissues:

The cells of this tissue are known as muscular cells or muscle fibers. They differentiate from the rest of body cells with their abilities of contraction and relaxation. This helps the organism to move. There are three types of muscular tissues:

 Smooth muscles:

They are composed of unstriated involuntary muscle fibers. They are present in the walls of viscera such as the wall of digestive canal, urinary bludder and blood vessels.

 Skeletal muscles:

They are composed of striated voluntary muscle fibers. They are usually connected with the skeleton, such as muscles of arms, legs and trunk.


Figure (29): Smooth muscule fibres

 Cardiac muscles:

They are composed of striated involuntary muscle fibers and present in the heart wall only. They contain special parts called intercalated discs that bind the muscle fibers together and make the heart beats in a rhythmic way as a functional unit

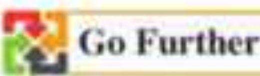

Figure (30): Skeletal muscle fibres


Figure (31): Cardiac muscle fibres

• The following link in the Egyptian Knowledge Bank (EKB) illustrate the structure and function of muscular tissues

Fourth: Nervous tissues:

The cells of nervous tissues specialize in receiving sensory stimuli whether they are internal or external the body and connect them to the brain and the spinal cord, then transmitting the motor impulses from one of them to effector organs (muscles or glands).



For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



Science, Technology and Society

 Stem cells

Recently, scientists have discovered that there is a type of cells has the ability to form any other type of specialized cells such as muscle cells, liver cells, nerve cells and skin cells. This can be done according to specific environmental treatments at the laboratory. These cells are called stem cells. These cells are formed during the early stage of forming the embryo. As a result, scientists and doctors are hoping to use such cells to treat a group of intractable diseases such as using these cells to produce dopamine used to treat those suffering from Parkinson disease or to transplant stem cells to give cardiac muscle cells as compensation about the damaged cardiac muscles in heart patients or getting cells producing the insulin hormone as a compensation about the decrease of secreting this hormone by pancreas for diabetes patients and other diseases.


Embryo cells in the early growth stages.



Cell fractionation


Ultracentrifuge

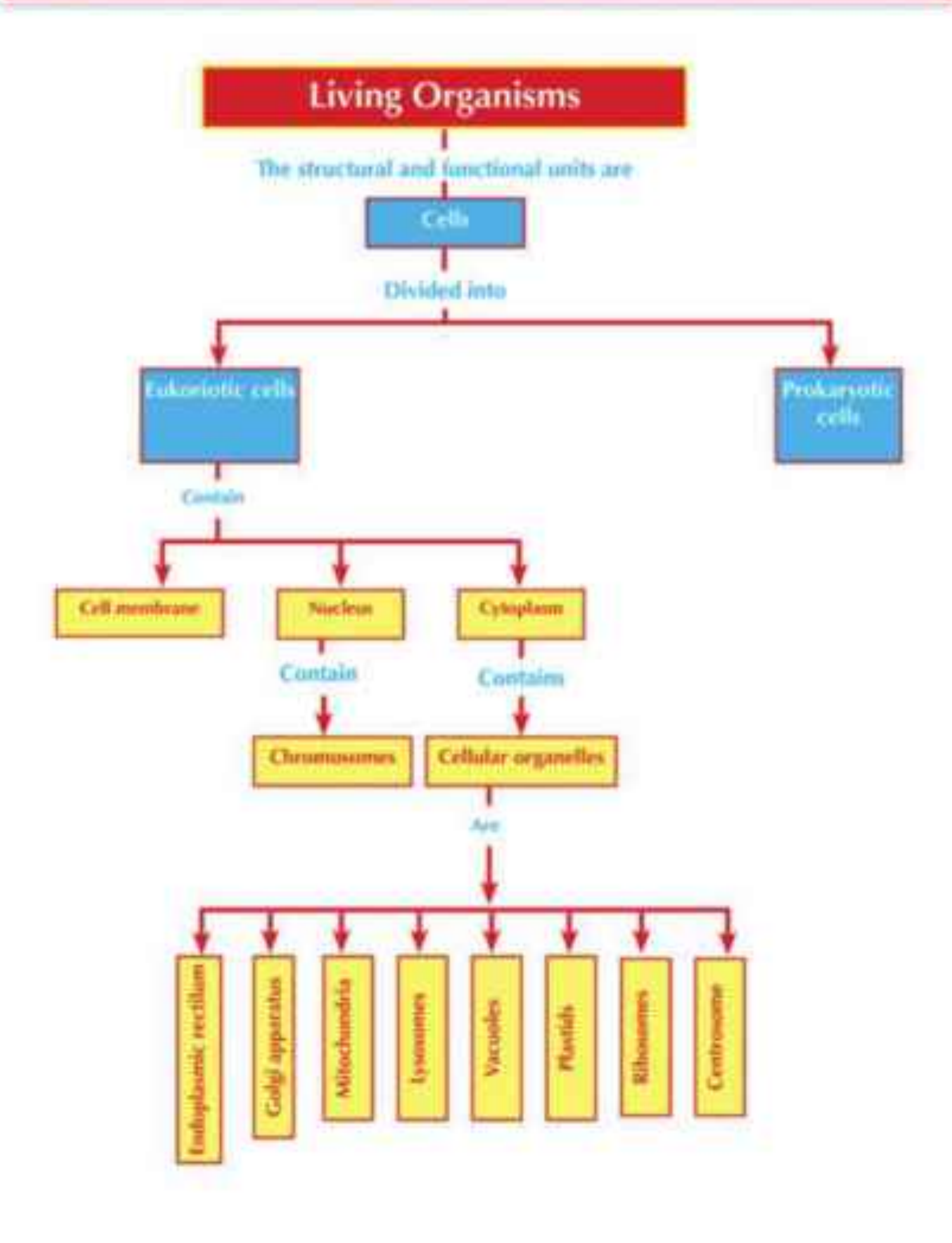
Technology of cell fractionation is one of the modern technologies used to study each type of different cells forming a certain tissue. Studying the different organelles forming one type of cells includes studying the site of these organelles, their functions and their components. Cell fractionation technology benefits in studying the cellular molecules such as biological macromolecules like enzymes. Furthermore, studying biological processes occurring inside the cell.

The Cell fractionation technology depends upon using ultracentrifuge apparatuses to separate cell organelles at different speeds depending on the different densities of these organelles.

Key terms

- **Cell theory**: It states that the cell is the basic functional unit of all living organisms. Organisms are composed of cells and these cells may be single or in groups. All the cells originate from pre - existing cells.
- **Prokaryotic cell**: It is the cell which its genetic material is not surrounded by a nuclear envelope and membranous organelles are absent from it.
- Eukaryotic cell: It is the cell which its genetic material is surrounded by a nuclear envelope and contains most cellular organelles.
- **Parenchyma tissue:** It is a tissue made up of irregular sheped cells with thin walls. It performs several functions such as photosynthesis, storing nutrients such as starch, and aeration.
- **Collenchyma tissue:** It is a living tissue and its cells are somewhat rectangular-shaped. It has thickened, irregular walls uncovered with legnin.
- **The sclerenchyma tissue:** It is a tissue strengthening and supporting the plants and protecting the internal tissues.
- **Epithelial tissue:** It is a tissue covering the surface of the body from the outside to protect it from external stimuli such as temperature, drought, and pathogens.
- **Connective tissue:** The cells of this tissue are somewhat distant and present in fluid, semisolid, or solid intercellular substance.
- **Muscular tissue:** Its cells are known as muscle cells or muscular fibers. It is distinguished from all the body cells with its ability to contract and relax.
- **Nervous tissue:** Its cells are specialized in receiving the sensory stimuli.
- **Chromosome:** It's a structure appearing in the metaphase of cell division. It is composed of two filaments each of them called chromatid. They are connected at a central part called centromere.

Concept Map of Chapter Two



Practical activity  **Examination of different types of plant and animal tissues**

Procedure:

Safety precautions



Activity goal

Identification of different types of plant and animal tissues.

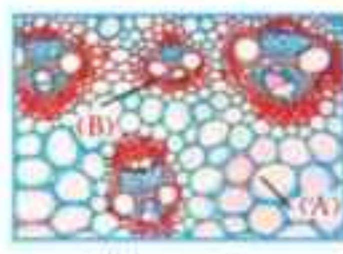
Acquired skills

Observing , scientific drawing , recording and analyzing data.

Materials needed

Prepared slides of various plant and animal tissues , and compound microscope.

1. Microscopically examine a group of slides that your teacher will give you.
2. Compare these slides with the following figures, then answer the following questions.



Slide no. (1)


Slide no (2)


Slide no. (3)


Slide no. (4)


Slide no. (5)

3. Specify the types of tissues in the slide no(1)

A- ....

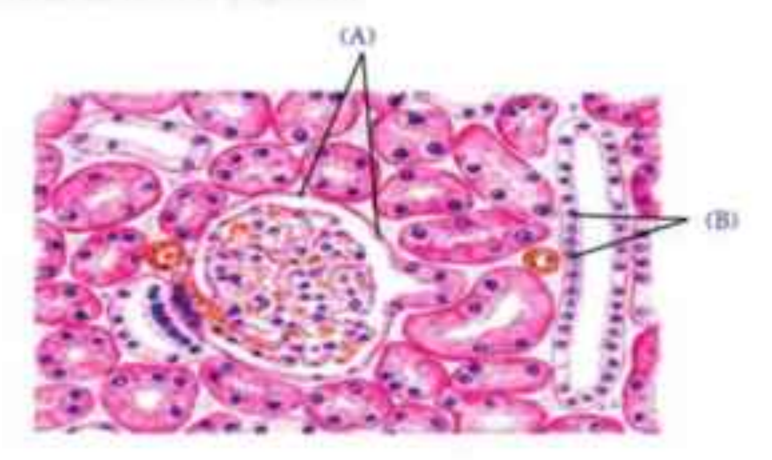
B- ....

4. Mention the types of tissues shown in slides (2), (3) , (4) and (5)

- Slide no. (2): ....
- Slide no. (3): ....
- Slide no. (4): ....
- Slide no. (5): ....

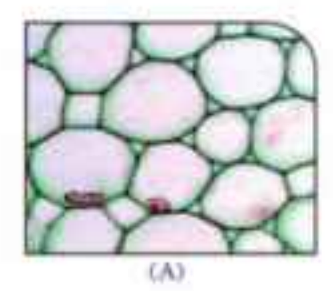
Assessment activity

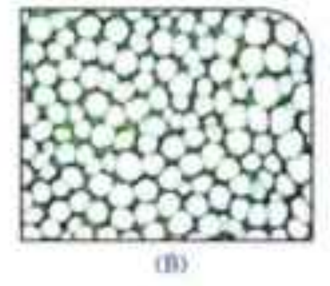
1 The following figure illustrates the histological structure of a section in kidney. In light of study of distinguishing characteristics of animal tissues, specify the types of tissues that referred to in this section.

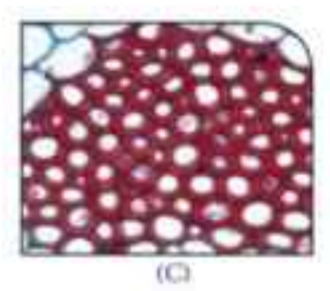


- The type of tissue (A): ______________________
- The type of tissue (B): ______________________

2 The following figures show 3 types of plant tissues . Examine these tissues, then answer the following questions:


(A)


(B)


(C)

- Mention the name of each tissue of them.

____

____

- Identify the type of the precipelated material on the walls of the tissue cells (B) and (C).

____

____

Second unit exercises

First question: Give the scientific term for each of the following:

1. A microscope, its magnification power reaches to 1500 times at maximum. ( )
2. A tissue consists of one type of cells. ( )
3. A tissue covers body surface externally and lines body cavities internally. ( )
4. Tissues that their cells are specialized in receiving the different external stimuli. ( )
5. Muscles composed of striated muscle fibres, and do not under the will in their work.( )
6. Parts of muscular tissue of the heart that make it pulses as a functional unit. ( )
7. Cellular structures responsible for protein synthesis. ( )
8. Cellular structures responsible for energy production in the cell. ( )
9. Minute interlaced filaments that are tightly coild around themselves and change into chromosomes during cell division. ( )

Second question: Choose the correct answer:

1. Chloroplastids in the plant cell is concerned with:

A. performing photosynthesis B. storing energy C. storing excess food D. secreting protein

2. plasma membrane consists of :

A. one layer of phospholipids B. two layers of phospholipids
C. two layer of cellulose D. two layers of chitin

3. The small particles that found on the outer surface of rough endoplasmic reticulum are the ....

A. centrosome B. ribosomes C. cytoplasm D. plastids

4. All the following organisms are found in the animal all except:

A. centrosome B. mitochondria C. golgi apparatus D. chloroplastids

5. The tissue responsible for transporting water and salts from the root to leaves is the :

A. xylem B. phloem C. parenchya D. collenchyma

Third question: Compare between each pair of the following:

1. Light and electron microscapes
2. Cell membrane and cell wall.

Fourth question : Give reasons for each of the following:

1. Naming skeletal muscles by this name.
2. Epithelial tissues cover body surface externally.
3. Lysosomes can decompose the senile and worn organells.
4. Golgi bodies are abundant in glandular cells.
5. Plant cells have a difinit shape.
6. Plasma membrane has an important role in the cell.
7. Plant cells can perform photosynthesis, whereas animal cells can not do this process?

Fifth question: Mention the role played by each of the following scientists in discovering the cell:

1. Robert Hooke. 2. Schleiden. 3. Schwann. 4. Virchow.

Sixth question: Mention the function of each organelle of the following:

1. centrosome. 2. Golgi bodies. 3. Lysosmes.

Miscellaneous questions:

1. Mention the main principles of cell theory?
2. Write down the name of 2 cellular organelles and their function.

Unit Three

Inheritance of Traits

We have blue, brown, green and gray eyes. Also, we have hair of different colours - black, brown and blonde. We see the ornamental sparrows with green, blue and yellow feathers. From where all these colours of living organisms come? How do these characteristics transmit from parents to their offspring?

The ancient prevailing belief before mendel`s experiments was that these colours are produced by the colours mixing theory. It is believed that the hybridization between two parrots, one with yellow feathers and the other with blue ones, will produce parrots with green feathers.

Recently, after discovering the chromosomes and the traits they carry on, the concept of traits inheritance has been changed and becomes obedient to laws and mechanisms which control the transmission of traits from a generation to another generation. The prediction of traits appearance in the produced individuals becomes more accurate and this helped in the prediction of genetic disorders in the offspring. This aggrandizes the importance of the medical examinations before marriage to avoid the transmission of genetic diseases to offspring.

For more information about the topic of Inheritance of Traits, log in the net.

Time Management:

To achieve the maximum benifit of this unit, you need to:

- Manage your time between practical and theoretical study, search and extending of information resources.
- Carefully record the results of your practical study which is the best way to support your learning.

Learning Outcomes

By the end of this unit the student should be able to:

- Explain the chromosome theory.
- Identify what is meant by the karyotype.
- Identify the number of chromosomes in some living organisms.
- Explain the mean of linkage.
- Identify what is meant by crossing over.
- Demonstrate the effect of genes interaction.
- Give examples of genes interaction.
- Explain the effect of the environmental conditions on the action of some genes.
- Explain how blood groups are inherited in humans.
- Explain how rhesus factor is inherited.
- Explain the role of sex chromosomes in sex determination.
- Mention some sex-linked, sex-influenced and sex-limited traits.
- Distinguish between some abnormal cases of chromosomes in humans.
- Mention some methods used to predict the likelihood of genetic disorders occurring in offspring.
- Appreciate the importance of medical examinations before marriage to avoid the genetic diseases.

Unit Three

Chapter 1

Chromosomes and Genetic Information

By the end of this chapter, you Should be able to:

- Explain the chromosome theory.
- Clarify the relation between the chromosome and gene.
- Identify what is meant by the karyotype in humans.
- Identify the number of chromosomes in some living organisms.
- Compare between the karyotype of the male and female humans.
- Explain the meaning of the linkage.
- Identify what is meant by crossing over.

Key terms

- Chromosome
- Chromosomal theory
- Gene
- Karyotype
- Crossing over

From a long time ago, man searches about how do genetic traits transmit across the successive generations and the causes of similarities and differences in genetic traits.

At the beginning of the twentieth century, scientists discovered that genetic information are carried on the chromosomes which lead to the appearance of traits in all living organisms.

The chromosomes are located inside the nucleus of each cell. They are found in homologous pairs in the somatic cells.

The following figure illustrates the chromosomes in cells of humans pancreas and white blood cells.

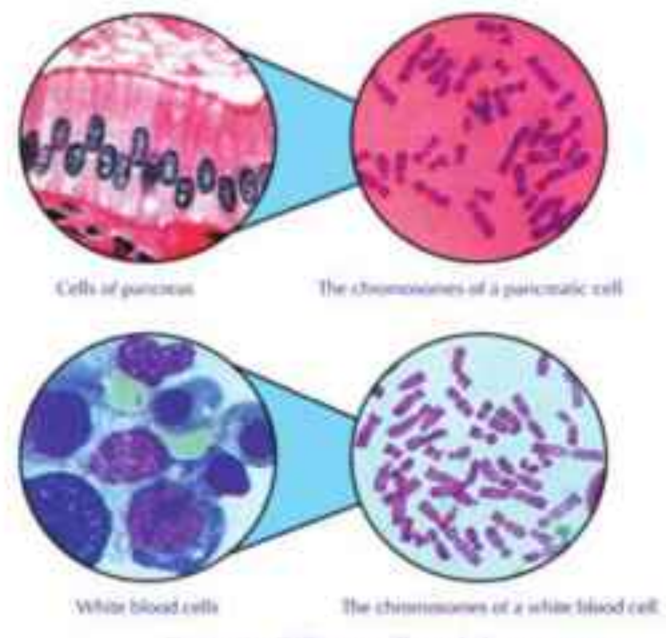


Figure (1): Different cells and chromosomes.

Al-Ashraaf printing House

Karyotype

We can photograph the chromosomes when they are in the clearest form using the microscope, then be demarcated and classified into homologous pairs.

After that, they arranged descendingly according to their size. To facilitate carrying out of this task, chromosomes can be coloured with different colours.

Enrichment

chromosomes are found in homologous pairs. Their number in cells of the living organism dosen't express the degree of its advancement or its size.

The descending arrangement of chromosomes according to their size and numerating them are called the karyotype.

The following figures illustrate the karyotype of both the human male and female.

Observe and identify:

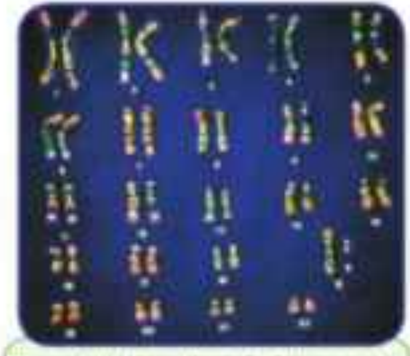


Figure (2): Karyotype of a human male

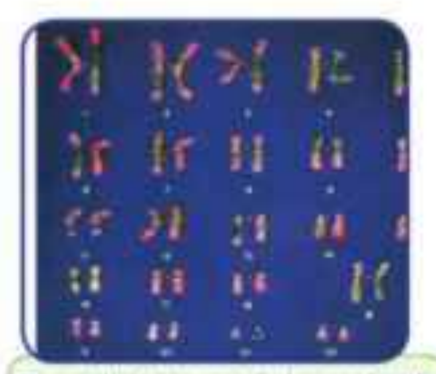


Figure (3): Karyotype of a human female

- **How many pairs of chromosomes in both Karyotypes of the male and female?**
- **What is the difference between the Karyotype of both the male and female?**

Number of chromosomes

The number of chromosomes in living organisms differs from a species to another, but it is constant in the individuals of the same species. Somatic (body) cells contain two sets of homologous chromosomes (one of them is inherited from father and the other from mother). These ells are called the diploid cells (2N), while gametes (sperms and pollens are male gametes and ova are female ones) contain half of the chromosomes number found in the somatic cells, i.e. they are haploid cells (n).For example, the nucleus of each human somatic cell contains 46 chromosomes (23 pairs), while the nucleus of both the male gamete (the sperm) and female one (the ovum) contains 23 chromosomes only.

• Chromosomes are descendingly arranged in homologous pairs according to their size from number (1) to number (23). The pairs from number 1 to number 22 are called somatic chromosomes, while the pair number 23 represents the sex chromosomes. This pair is not subject to this arrangement where it comes after the seventh pair in size, but it is arranged at the end of chromosomes and given the number (23).

• The karyotype of male differs from that of the female in the pair of sex chromosomes. This pair is asymmetric (heterzygous) in male (XY) (Fig. 4) and symmetric (homozygous) in the female (XX) (Fig. 4) and called the pair of sex chromosomes because it carries the genetic information of sex determination.

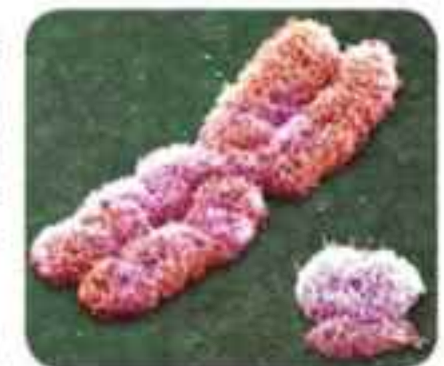


Figure (4): The sex chromosomes pair (XY).

• The constancy of the chromosomal number in both the males and females of all members the human race indicates that chromosomes carry the genetic information which determine the characters of humans and other living organisms.

✲ The following table represents the chromosomal number in cells of some living organisms:

Table(1): The chromosomal number in cells of some living organisms.

Species	No. of chromosomes in the somatic cells	Species	No. of chromosomes in the somatic cells
Human	46	Gorilla	48
Hen	32	Wheat Plant	42
Cat	38	Onion plant	16
Vinegar fly	8	Sweet potato plant	48
Dog	78	Pea plant	14
Tobacco plant	48	Frog	26

✍ What can be concluded from this table?

Chromosomal Theory

By 1902, the two scientists Sutton and Boveri had reached to the priciples of chromosome theory which can be crystallized in the following main points:

- Chromosomes are found in the somatic cells as homologous pairs (2n).
- Sex cells (gametes) contain the half of chromosomal number (n) due to meiosis where the pairs of homologous chromosomes are segregated into two equal sets of chromosomes.
- Each pair of chromosomes behave independently at its transmission in gametes.

Enrichment

Scientists found that there are 60-80 thousands genes carried on twenty three pairs of chromosomes in humans. The complete set of genes in known as the human genome

- During fertilization the diploid number of chromosomes returns again.
- Genes are located on the chromosomes and the single chromosome may carry hundreds of genes.

Chromosomes and genes

The chromosome is composed of the nucleic acid DNA and protein. DNA molecule carries the genes responsible for the genetic traits in living organisms.

You have learned that DNA consists of building units called nucleotides. The gene consists of a sequence of nucleotides that represents a code of a protein responsible for the appearance of a certain trait.

Interpretation of Mendel's laws according to the chromosome theory:

The opposite figure illustrates the inheritance of a pair of allelomorphic (contrasting) characteristics in pea plant:

- What is your explanation for the appearance of the purple colour only in the first generation plants?
- What is your explanation for the appearance of the two colours in plants of the second generation?

P ×
F1
F2

Figure (5) : Law of genetic factors segregation

- In the meiotic division, the genes carried on the chromosome pairs are segregated into the gametes, and during fertilization the chromosomes return back again in pairs.

- The dominant trait appears in the first generation in a percentage 100%. The dominant and recessive traits appear together in the second generation in a ratio 3:1 , respectively.

- The opposite figure explains the inheritance of two pairs of the characteristics studied by Mendel in his experiments, such as: the colour and shape of seeds in pea plants.

The yellow colour gene (Y) of seeds is dominant on the green colour gene (y), and the smooth shape gene (S) of seeds domiates over the winkled shape gene (s).

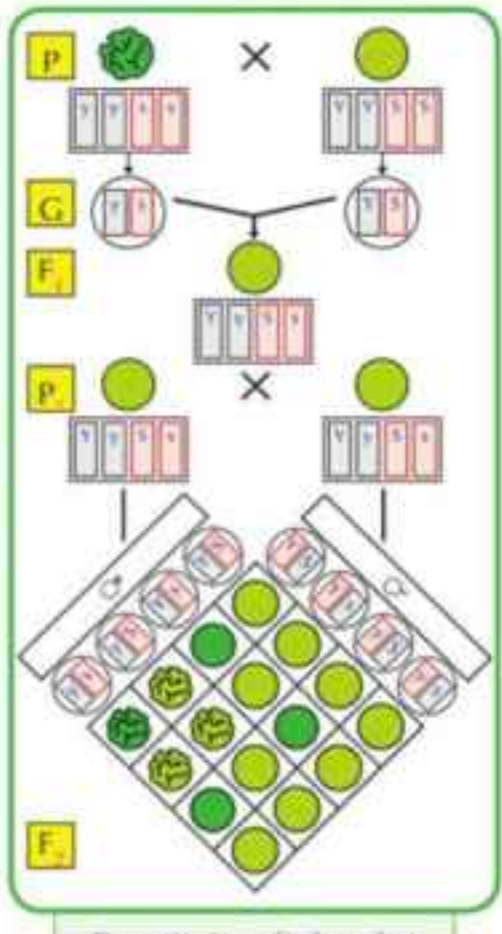
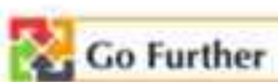


Figure (6) : Law of independent assortment of genes

- Are the genes of seeds colour and that of seeds shape located on the same chromosome or on two different chromosomes?
- What are the possibilities of genes assortment into the gametes?
- What are the ratios of the appearance of the two characteristics in members of both the first and second generations?

- The assortment of genes carried on the chromosomes in gametes is independent because each gene is located on a separate chromosome.
- The individuals of the first generation carry the two dominant characteristics (the yellow colour and smooth shape) in a percentage 100%.
- The ratio is 9:3:3:1 in the individuals of second generation.



For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



Unit Three

Chapter 2

The Interaction of Genes

By the end of this chapter, you should be able to:

- Demonstrate the effect of genes interaction.
- Mention the mean of lack of dominance.
- Explain the lack of dominance.
- Explain the complementary genes.
- Explain the lethal genes.
- Explain the inheritance of blood groups in humans.
- Show the bases of classifying blood into four groups.
- Identify a blood group.
- Compare the four blood groups.
- Explain how rhesus factor is inherited.
- Analyze inheritance of some traits on genetic bases.
- Explain the effect of the environmental conditions on the action of some genes.

Key Terms

- Complete dominance
- Lack of dominance
- Complementary genes
- Lethal genes
- Blood groups
- Antigens
- Antibodies
- Rhesus Factor (Rh)

Gregor Mendel arrived to that each trait is controlled by one pair of genes, one of them is dominant while the other is recessive. Later, scientists found that several traits were not inherited according to Menel's laws and called non-mendelian characteristics. They include cases in which the emergence of gentic traits is affected by the interaction of the allelomorphic genes.

• Examples of gene interaction are: lake of dominance, complementary genes and lethal gene.

Remember

• Each pair of alternative character is calld allelomorphic characters.

• In case of Mendelian chracter: when crossing occurs between to pure (homozygous) indiviluals, one of them having the dominant chracter and the other having the recessive one, the individuals of the first flial generation will all show the dominant chracter. While the tow chracters,the dominant and recessive, appear together in ratio 3 : 1, respectively, in the second flial generation. This genetic pattern is called the complete dominance.

Lack of Dominance

In *Antirrhinum* plant, the flowers are chracterized by three colours: red, white and purple. The following figure illustrates crossing of a plant with red flowers (RR) with another plant with white flowers (WW).

✍ What is the flower colour of the first generation plants?

- What are the possible genotype of first generation individuals?
- When first generation plants are self polinated and their seeds are cultivated, What are the possibilities of the flowers colour inheritance in plants of second generation?
- What is the ratio of the flowers colour in plants of second generation
- Do these results agree with Mendels laws?

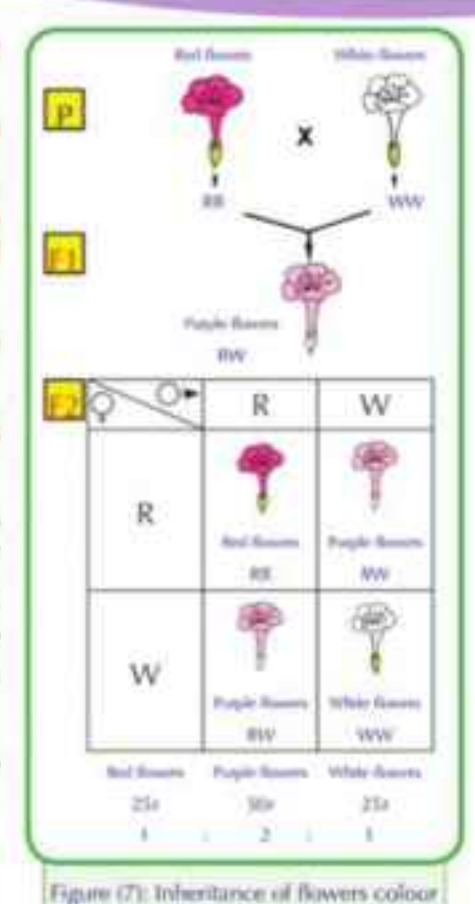
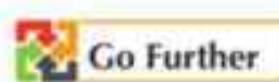


Figure (7): Inheritance of flowers colour in *Antirrhinum* plant.

The gentic analysis (fig.7) illustrates that the flowers colour chracter is controlled by a pair of genes, no one of them dominates over the other. This happens due to the gene interaction where each one of these allelomorphic genes has an effect in the appearance of the new chracter.

- Notice that the phenotype indicates the genotype in case of lack of dominance.

Inheritance of blood groups in humans:



Go Further

For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



Genetic classification of blood groups:

Blood groups include three patterns in heredity, they are:

✲ **Multiple allels**: Blood groups trait is carried by three allelomorphic genes: A,B and O. The individual has only one pair of them.

✲ **Complete dominance**: Both genes (A) and (B) dominate over the gene (O).

Table (2): Blood groups and their genotypes

Group	Genotype	
A	AA	AO
B	BB	BO
AB	AB	
O	OO	

✲ **Lack of dominance**: There is dominancy between gene (A) and gene (B). They participate together in production of a new trait, which is AB blood group.

The opposite diagram shows mating of a man has blood group (AB) and a woman (O).

- What are the expected blood groups of offspring?
- What is the ratio of blood group among offspring?
- Are there possibilities of other blood groups?

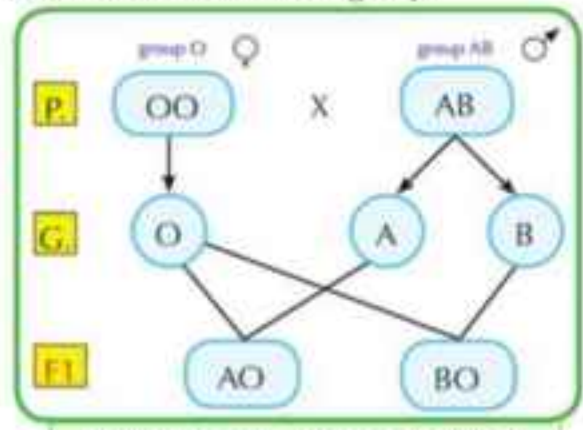


Figure (8): Genetic analysis of blood group inheritance.

Chemical classification of blood groups:

Classification of blood groups into four groups (A), (B), (AB) and (O) depends upon two types of substances found in blood. Thes substances are divided into two types:

Table (3): A table shows blood groups classification

The group	Antigens	Antibodies
A	A	anti-b
B	B	anti-a
AB	A and B	-------
O	-------	anti-a anti-b

Antigens:

They are the substonces that found on the surface of red blood cells. They are two types: antigen (A) and antigen (B).

Antibodies:

These substances are antithetic to antigens and found in blood plasma. They are two types: (anti - a) and (anti - a).

- Use table (3) to compare between the four blood groups.

Life application

A dispute took place between two men about the eligility of each in the parenty of a baby has the blood group (O). The blood group of both men was (O) and blood group of the first man wife was (A) while the blood group of the cecond man was (AB)

Importance of blood groups :

1. Dispute resolution in determining paternity and enrollment children to their real parents (blood groups can denying but can not pove the parevtage).
2. Determining the processes of blood transfusion among individuals.



3. Used in studies of human race taxonomy and studying evolution.

Blood transfusion processes:

Blood can be transfused between different groups according to a specific system due to the presence of antigens and antibodies.

✲ Table (4) shows the possibilities of blood transfusion between different groups:

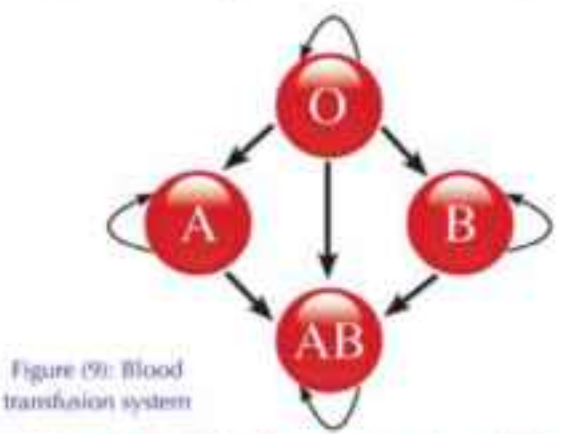


Figure (9): Blood transfusion system

Table (4) Blood transfusion system

The receiver \ The donor	O	AB	B	A
A	✓	✗	✗	✓
B	✓	✗	✓	✗
AB	✓	✓	✓	✓
O	✓	✗	✗	✗

✍ What is the blood group that is called universal receiver? Why?

✍ What is the blood group that is called universal donor? Why?

The following table summarizes some information of the four blood groups:

Table (5): Blood groups

Group	Genetic structure		Antigens	Antibodies		Donates to	Receives from
A	AA	AO	A	anti-b		A and AB	A and O
B	BB	BO	B	anti-a		B and AB	B and O
AB	AB		A and B	-----		AB	All groups
O	OO		-----	anti-b	anti-a	All groups	O

Determination of the type of a blood group:

Each group of blood has certain antigens and their corresponding antibodies. For example:

The antigens (A) are agglutinated with antibodies (a).

Through the reactions that take place between antigens and antibodies and occurrence of blood agglutination, the type of a blood group can be determined.

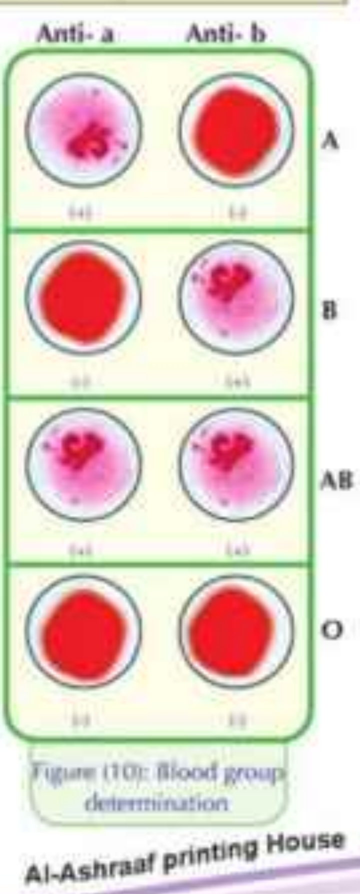


Figure (10): Blood group determination

Procedure of blood group type determination:

To determine the blood group, both types of antibodies, anti-a and anti-b, are needed:

1. A blood sample is drawn from the person to be determining his blood group. Then two drops of blood are placed on clean glass slide.
2. We put anti-a on a drop of them and anti-b on the other drop.

 The result: There are four possibilities, which are :

Table (6): Determination of blood groups

	First blood drop with anti - a	Second blood drop with anti - b	The possible blood group
1	Agglutination (+)	No agglutination (-)	A
2	No agglutination (-)	Agglutination (+)	B
3	Agglutination (+)	Agglutination (+)	AB
4	No agglutination (-)	No agglutination (-)	O

- **Discuss your classmates and your teacher the results in this table.**

Life application

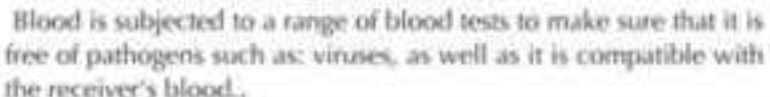
Risks of blood transfusion

There are some risks related to blood transfusion that the reciver exposed to:



Blood transfusion

- When an incompotible blood with his blood group is transfused to him. This includes symtoms such shiver, headache, chest pains, breath lessness, blueness, tachycardia, hypotension and often ends with death.
- A viral infection can be transferred to the receiver as hepatitis C which its infection takes place by blood transfusion only since it does not transferred among couples or from the mother to the fetus, and AIDS viruses.



Blood is subjected to a range of blood tests to make sure that it is free of pathogens such as: viruses, as well as it is compatible with the receiver's blood..

Rhesus factor (Rh)

Beside the antigens of blood groups, there is another type of antigens on the surface of red blood cells known as Rhesus factor antigens. These antigens are found in blood of almost 85% of human beings who are known as positive Rhesus factor, and symboled as (Rh^+). While, the persons who have no this type of antigens in their blood and represent about 15 % of hunan beings are known as negative Rhesus factor, and symbled with (Rh^-).

The inheritance of Rhesus factor antigens is controlled by three pairs of genes, located on a pair of chromosomes.

The presence of any gene or more of these three gene pairs in the dominat statae leads to the formation of rhesus factor antigens, and the person becomes positive Rhesus factor (Rh^+), whereas all genes of the negative Rhesus factor individual (Rh^-) are recessive.

Figure (11): A red blood cell

Importance of Rhesus factor

Rhesus factor determination should not be neglected before blood transfusion, as well as before marriage to avoid risks arising from the formation of antibodies for Rhesus factor antigens that cause disintegration of red blood cells.

Role of Rhesus factor in pregnancy and delivery:

If a (Rh^+) man is married to (Rh^-) woman, and the fetus inside the uterus was (Rh^+), a portion of fetus blood mixes with his mothers blood at delivery. This stimulates her immune system to produce antibodies against antigens of Rhesus factor and these antibodies remain in mother's blood.

If the mother carried (Rh^+) fetus, the antibodies formed from the first pregnancy move from mother's blood to blood of fetus through placenta (fig. 12). These antibodies cause the disintegration of red blood cells infecting the fetus with sever anaemia that may lead to his death.

The preventive measure that we can do in case of discovering this difference before the delivery of the first baby is the injection of mother with a protective serum through 72 hours after each birth to protect the future baby.

This serum disintegrates the blood containing (Rh^+) that leaked from blood of fetus to mother's blood before enhancing mothers immune system to form antibodies.

Enrichment

Rhesus factor antigens were first discovered in 1940 when researches were carried out on blood of a kind of monkeys called Rhesus monkeys.

Therefore, these antigens were given the name of Rhesus factor.

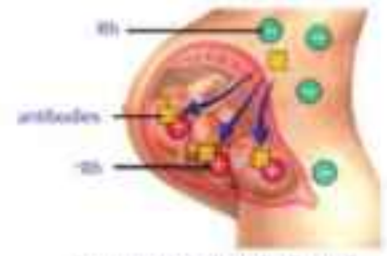


Figure (12) : Transferring of antibodies from mother's blood to the blood of second fetus through mothers placenta.

Complementary Genes

Complementary genes are the genes that can often work together to emerge a specific trait, where the inheritance of this trait is controlled by 2 pairs of genes. The emergence of the dominant character depends on the presence of a dominant gene at least in each pair. While, absence of any pair of dominant genes or both, will lead to disappearouce of the dominant character and the recessive allelomorphic character appears.





Figure (13) Pea flower plant.

An example of complementary genes is the inheritance of the flower colour character of pea flower plant. The pink colour represents the dominant trait while the white colour represents the recessive one, fig.13.

The character of flower colour in pea plant is carried by two different pairs of dominant genes and symboled by the two letters A and B , while the recessive genes are symboled by a and b .

The opposite figure shows the crossing of 2 stains of pea flower plants, each of them carries white coloured flowers.

✍ What is the flowers colour of first generation plants?

✍ What are the possible genotypes of individuals of this generation?

✍ When self - pollination was carried between the first generation plants, then their seed were cultivated, what are the possibilities of the flower colour character inheritance in second generation plants?

✍ What is the ratio of emergence of flower colour in second generation plants?

✍ Write down the different genotypes for each of the pink flowers and white ones.

✍ Are these results in agreement with Mendels second law (Law of independent assortment) ?

P. — White flowers: AA bb X White flowers: aa BB

G. — Ab, aB

F_1 — Aa Bb (Pink flowers)

P. — Pink flowers: Aa Bb X Pink flowers: Aa Bb

F_2

Gametes	AB	Ab	aB	ab
AB	**AA BB**	**AA Bb**	**Aa BB**	**Aa Bb**
Ab	**AA Bb**	AA bb	**Aa Bb**	Aa bb
aB	**Aa BB**	**Aa Bb**	aa BB	aa Bb
ab	**Aa Bb**	Aa bb	aa Bb	aa bb

Pink flowers : White flowers

9 : 7

Figure (14) : Inheritance of flower colour in pea plants.

When white flowered pea plants were crossed together , all the flowers of the first generation plants appeared pink (in a ratio 100%). In the second generation, the flower produced were pink and white in a ratio 9 : 7 , respectively.



The appearance of pink colour (dominant character) in flowers of pea plants depends on gathering a dominant gene from each pair or more , because both of the two dominant genes participate to produce the pink colour of flowers where each of them controls the production of a specific enzyme that affect the formation of pink colour. This indicates the complement of action of genes , where in this case the dominant character can be obtained from two parents , each carries the recessive character.

The ratio of the second generation in case of Mendelian characters (law of segregation of factors) is 9 : 3 : 3 : 1 , while the ratio of second generation in non - Mendelian characters (complementary genes) is 9 : 7 .

Lethal Genes

Some genes when present in a homologous condition (pure) cause harms to the living organism resulting in disruption of some vital processes leading to the death of organism at different stages of life .

✲ These genes are called the lethal genes. There are two types of these genes, which are:

1. Dominant lethal genes : such as yellow fur colour in mice and bulldog strain in cattles.
2. Recessive lethal genes : such as absence of chlorophyll in corn plants and infantile dementia in humans.

Inheritance of fur colour of mice:

The opposite figure shows mating of a male and a female mice. Each of them has a heterozygous yellow fur and the ratio of the resulted generation was 2 : 1.

- What is fur colour of the resulted generation?
- What are the possible genotypes of individuals of this generations?
- Why do these results disagree with Mendel`s first law (law of segregation of factors) ?
- What is percentage of loss of mice first generation?

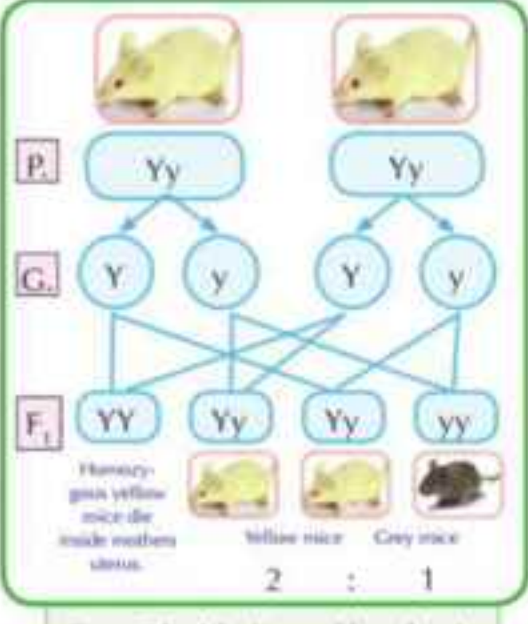


Figure (15) : Inheritance of fur colour in mice

The death of pure yellow mice is attributed to presence of a pair of dominant genes in a homozygous state causing death of mice inside mother's uterus . These dead mice represent about 25% of individuals of the resulted generation. The inheritance of this disease takes place through heterozygous parents.

Inheriting the absence of chlorophyll in corn plants:

It was observed that when some corn plants were self pollinated and their seeds were cultivated, some seedlings free of chlorophyll (white coloured) were shortly grown , then wilt and die.

Apply what you learned.

in some infants, there is a genetic disease known as infantile dementia causes death when its genes are recessive (aa).

What is result when a man is married to a woman , each of them is hetrozygous in respect to this trait?

Study the opposite genetic analysis , then answer the following questions:

- What is the ratio of chlorophyll free seedlings among plants of the resulted generation?
- What is your justification for wilting and death of these seedlings?
- From your point of view , how can losing of plants be avoided and obtaining all seedlings green?

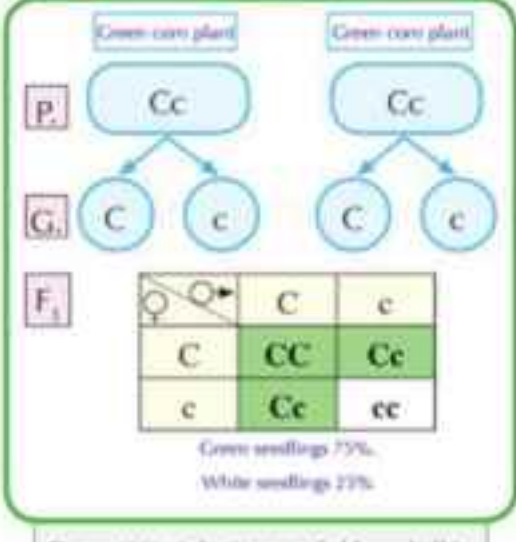


Figure (16) : Inheritance of chlorophyll in corn plants

The convergence of the two recessive genes together in some corn seedlings leads to prevention of chlorophyll formation. Chlorophyll substance acquires plants their characteristic green colour, as well as it is responsible for absorbing light energy for performing photosynthesis process.

Effect of environmental conditions on action of some genes

Many people thought that the action of genes is not affected by any other factors. But, recent researches has proven that the action of some genes is affected by the factors surrounding the organism such as air pollutants , oxygen deficiency, exposure to rays , in addition to the environmental factors such as light and temperature . Studying these factors affecting the action of genes helps in avoiding risks that may arise from these factors.

Effect of the absence of light on appearance of chlorophyll character in green plants:

Germinate a group of wheat or bean seeds in a dark room, and other similar group in a luminous place. Irrigate the seedlings in both groups regularly for several days.

- What is the colour of seedlings in both groups?



Figure (17) : Effect of light on the colour of wheat seedling's.

The gene responsible for chlorophyll formation in green plants needs to the factor of light to show its effect. While , in absence of this gene , the plant can not produce chlorophyll even if it was placed in light.

Unit Three

Chapter 3

Genetic Inheritance and Genetic Diseases

By the end of this chapter, you Should be able to:

- Explain the role of sex chromosomes in sex determination of the fetus.
- Distinguish between some abnormal chromosomal cases in humans.
- Mention some sex-linked, sex-influenced and sex-limited traits.
- Analyze some sex-linked and sex-influenced traits on genetic bases.
- State some methods used to predict the likelihood of genetic disorders occurring in offspring.
- Appreciate the importance of medical examinations before marriage to avoid the genetic diseases.

Key terms

- Klinefelter's Syndrome
- Turner's Syndrome
- Down's Syndrome
- Sex-linked traits
- Sex-influenced traits
- Sex-limited traits
- Colour blindness
- Hemophilia
- Baldness
- Albinism
- Polydactyly
- Genetic family tree

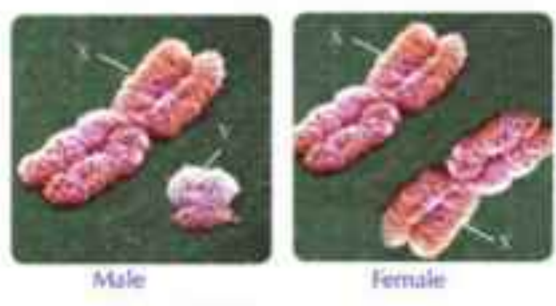
Sex determination remains a dream for many people a long time ago. The idea that the woman is responsible for determination of her fetus sex, male or female, remained untile the midde of the last century. By discovering sex chromosomes, scientists decided that man is responsible for determining of the sex of fetus.

✍ How can you explain that the man is responsible for sex determination of the fetus?

Sex determination in humans

there are 23 pairs of chromosomes in each human cell. these chromosomes are classified into 2 types:

1. Autosomes (Somatic chromosomes): their number is 22 pairs. They are similar in both the male and female.
2. Sex chromosomes: their number is one pair only and they are different in the male and female (Figure 18)



Male Female

Figure (18): The sex chromosomes

✲ **Female cells**: contain 22 pairs of autosomes, and an identical pair of sex chromosomes (44 + XX).

✲ **Male cells**: contain 22 pairs of autosomes and one different pair of sex chromosomes (44 + XY).

- The chromosome (X) differs from chromosome (Y) in size and type of genes each carries.
- The opposite genetic analysis illustrates the possibilities of giving birth of males and females.

  - What is the possible chromosomal structure for both of sperms and ova?
  - What is the ratio of males to females?

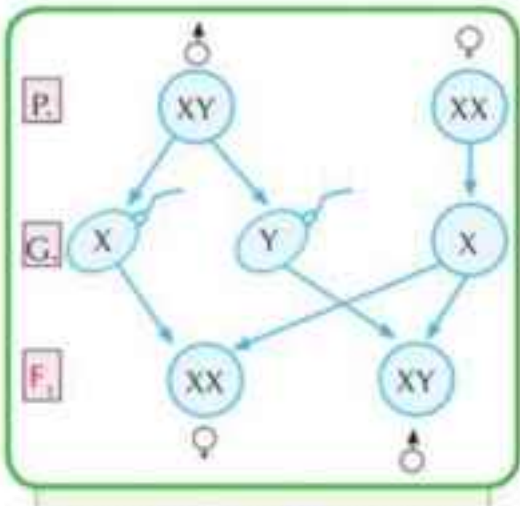


Figure (19): The possiblities of embryo formation

- The male and female gametes are formed by meiotic division of cells of gonads (testes in males and ovaries in females), therefore gametes contain half of the chromosomal number found in somatic cells.
- The male produces two types of gametes at equal ratios, sperms carry the chromosome (X) and other sperms carry the chromosome (Y). The female produces one type of ova carry the chromosome (X).
- When the ovum (22 + X) is fertilized by a sperm (22 + X), a female embryo will be produced.
- When the ovum (22 + X) is fertilized by a sperm (22 + Y), a male embryo will be produced.
- Sperms determine the sex of the embryo, not the ova.
- The genes carried on the two chromosomes (X) and (Y) that responsible for sex determination work at the first months of pregnancy.

Enrichment

In some animals, sex is determined according to the environmental conditions. For example, temperature that the eggs of turtles are exposed to, plays a role in sex determination. the eggs located near soil surface with higher temperature hatch females, while the eggs away from the surface of the soil with lower temperature produce males on hatching

- After 6 weeks of the beginning of pregnancy, the fetus which carries the chromosome (Y) begins in production of hormones stimulate the tissues of ganads (which are undifferentiated) to from the 2 testes, then the rest of male genital organs are differentiated.
- After 12 weeks of beginning of pregnancy, the fetus which does not carry chromosome (Y) begins in the formation of the 2 ovaries, then the rest of female genital organs are differentiated.

Abnormal chromosomal cases in humans

These abnormal cases take place due to errors in gametes formation. This leads to the formation of abnormal individuals as a result of a reduction or an increase in the number of sex chromosomes or autosomes.

✲ Examples of abnormal chromosomal cases:

Klinefelter's syndrome:

In 1942, Dr. Henery Klinefelter had discovered this case. Klinefelter's syndrome (44 + XXY) takes place due to the fertilization of an abnormal ovum (22 + XX) by a sperm (22 + Y).

The presence of an extra (X) chromosome leads to a disturbance in body hormones where the genes carried on the chromosome (X) express in some way.

From the symptoms of this case:

A sterile male due to absence of the sperm generating cells, and appearance of some femenine characteristics such as: growth of the breasts in size, tallness.

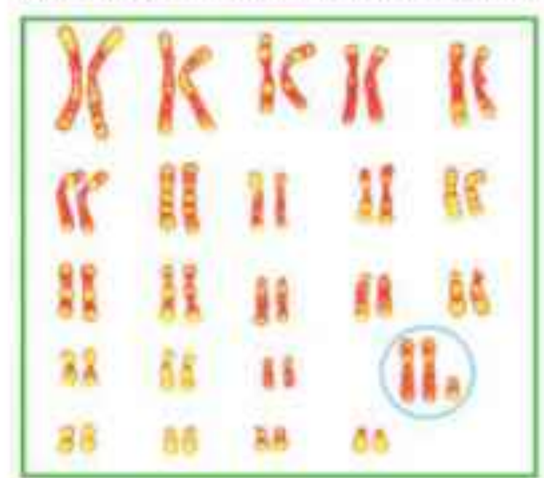


Figure (20): Karyotype of klinefelter's syndrome.

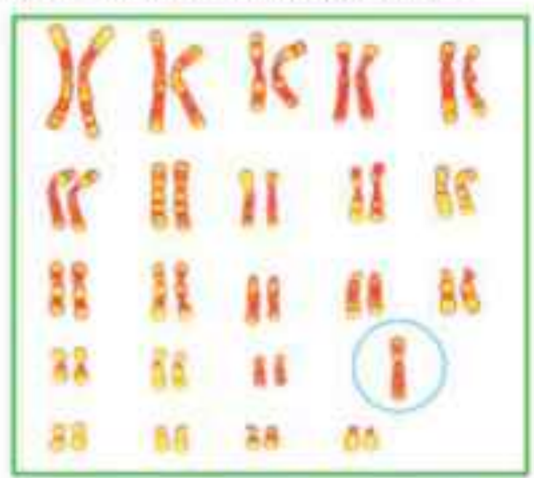


Figure (21): Karyotype of turner's syndrome.

- **Observe the difference of the chromosomal number in each case.**

Turner's syndrome:

Turner's syndrome (44+XO) occurs due to the fusion between an abnormal gamete (22 + O) by a normal one (22+X). The lacking of chromosome (X) which carries genes of non- sexual characteristics produces a female with several deformities.

From the symptoms of this case:

shortness, does not reach puberty due to lack of sufficient amount of hormones, and presence of some congenital defects in heart and kidneys.



Figure (22): Turner's syndrome.

Down's syndrome



Figure (23): Down's syndrome



Figure (24) : the karyotype of Down's syndrome

- **OBSERVE THE EXTRA CHROMOSOME NUMBER (21).**

The child shown in figure (23) suffers from a case called Down's syndrome.

✍ Describe the shape of his face and eyes.

Examine the karyotype in figure (24) which represents the Down's syndrome then answer the following questions:

✍ How many chromosomes in this karyotype?

✍ What is the number of the abnormal pairs of chromosomes? What is its type?

✍ Is this karyotype for male or female? Why?

✍ Is the emergence of this case is limited to a particular sex over the other? Give reasons.

✲ In 1866, the British doctor Down had discovered this case .
It results due to the fertilization of an abnormal gamete (a sperm or an avum) carries the pair of chromosomes no. 21, so a child carries three copies of the chromosomes no.21 in his body cells. It is an autosome. The child may be male (45 + XY) or female (45 + XX).

From the symptoms of this case:

A retarded growth, shortness, oval face, flat back of the head, fingers and toes are short, small ears, convex eyes, and mental retardation.

Sex-Linked Traits

Scientists discovered that the genes of some body characteristics in many animals are located on sex chromosomes (X and Y) and called sex- linked characteristics.

Thomas morgan is the first scientist discovered the sex- linked genes during studying the eye $X^R X^R$ colour chacter in *Drosophila* insect. He crossed white $X^r Y$ eyed males *Drosophila* whit red-eyed females. The following figure illustrates the crossing of a white-eyed male *Drosophila* with red-eyed female for 2 successive generation:

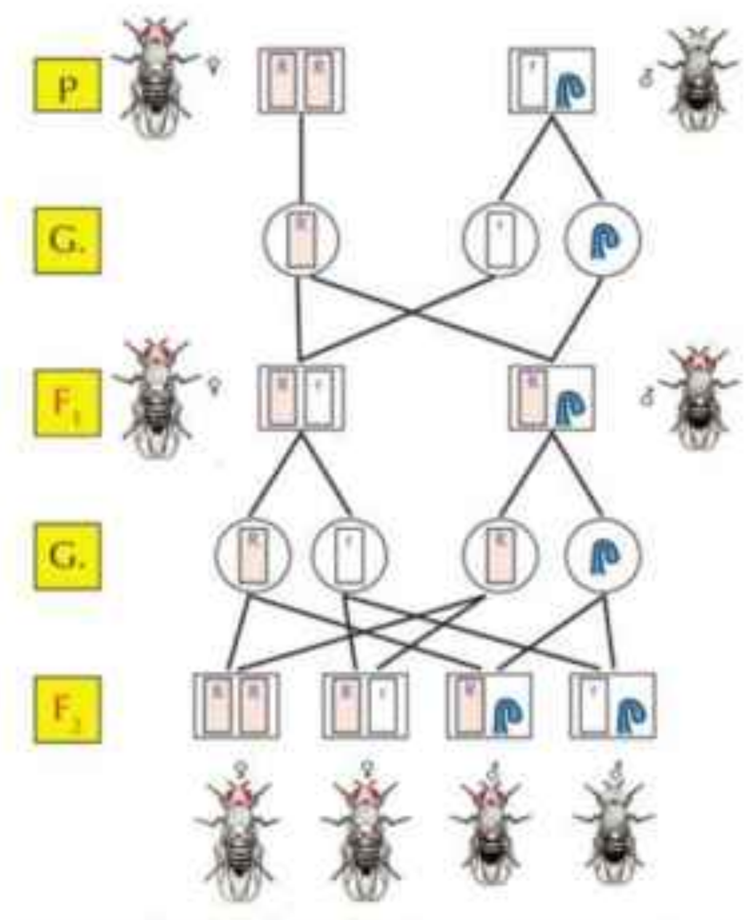


Figure (25): Inheritance of eye colour characteristic in *Drosophila* insects.

- What is the ratio of appearane of eye colour characteristic between the males and females of frist generation?
- What is the ratio of appearance of eye colour characteristic between the males and females of second generation?
- What is the sex of insects with white eyes among the members of second generation?
- Does this case agree with Mendel's first law (segregation of genetic factors)?

Morgan noticed that when white-eyed males *Drosophila* were crossed with red-eyed females, the members of first generation were red-eyed. This means that the red eyes characteristic is dominant over the white eyes one. When members of first generation were crossed with each other, red-eyed and white-eyed insects appeared in a ratio of 3 : 1, respectively. It was possible to consider this case as a Mendelian characteristic unless his observation that all white- eyed insects were males.

Morgan explained that these genes are carried on the sex chromosome (X), whereas the chromosome (Y) carries few genes only. He gave this case the name sex-linked characteristics. Therefore, Morgan considered that the eye colour of *Drosophila* insects is a sex-linked characteristic.

Enrichment

There are some genes on the chromosome (y) in the human male. There are no corresponding genes on the chromosome (x). therefore, the appearane of these traits, such as the presence of hair on ear margins, is restricted to males only.

Sex-linked characteristics in humans

In humans, the chromosome (X) carries the genes that responsible for some body characteristics such as: hemophilia, colour blindness, short-sightedness and muscle atrophy. The father passes the genes of these traits to his daughters, but not to his sons.

Colour blindness

The condition of colour blindness is caused by a recessive gene carried on the chromosome (X). This gene causes the inability to distinguish the colours especially the red and green ones.

The opposite genetic analysis shows the inheritance of colour blindness trait:

- Why is colour blindness trait represented by a single gene in males?
- What are the possibilities of this trait inheritance among the male and female offspring?
- Why does not father pass the colour blindness trait to his sons?

Healthy mother ♀ ♂ Sick father

P. $X^C X^C$ x $X^c Y$

G. X^C X^C X^c Y

F_1 $X^C X^c$ $X^C Y$

Healthy female (carrier) Healthy male

Figure (26): The inheritance of colour blindness trait in humans.

The sex linked trait is represented by a single gene found only in males because the chromosome (Y) does not carry colour blindness genes, and is represented by one pair of genes in the females due to the presence of a pair of sex chromosomes (XX)

- The male does not pass his trait to his sons because he passes the chromosome (Y), not (X) to them.
- The male passes his trait to his grandsons through his daughters, while the mother passes the trait to her sons and daughters.

Enrichment

The condition of muscle atrophy is caused by a sex-linked lethal recessive gene carried on (X) chromosome. This condition is restricted only to the males, not females. It's symptoms appear at the age of twelve years.

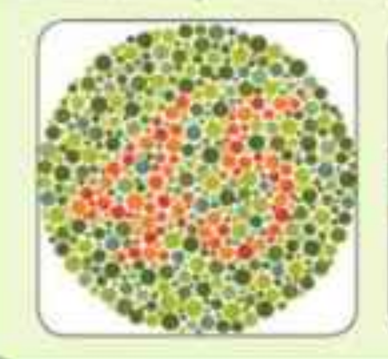
This condition causes a gradual atrophy of muscles and healing is not possible. It ends with death.

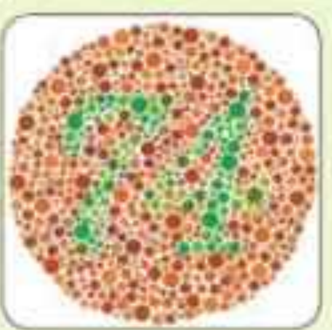
Test your eyes

Look at the following two figures:

- What is the number in both the first and second circles?

Your success in reading the numbers correctly indicates that you are healthy from colour blindness.





Haemophilia:

Haemophilia is caused by a recessive gene carried on the chromosome (X). This gene causes a case of blood liquidity due to the lack of some necessary substances necessary for blood clotting. Haemophilia may cause death especially in the childhood stage.

Sex-Influenced Traits

The genes of these traits are located on the autosomes, not on the sex chromosomes. Sometimes, the sex of the living organism acts to modify the dominancy of some traits, where the act of these genes are influenced by the male or female sex hormones, such as the presence of horns in cattels and baldness in humans.

Baldness:

The opposite genetic analysis shows the inheritance of hair falling trait:

- What are the possibilities of appearance of hair falling trait among the members of the resulted first generation?
- Is the ratio of hair falling trait appearance is eqlual among the two sexes? Why?

♀ Normal hair mother ♂ Bald headed father

P. B^+B X B^+B

G. B^+ B B^+ B

F_1

♀ \ ♂	B^+	B
B^+	B^{++}	B^+B
B	B^+B	BB

B^+B^+ Bald headed male and hair falling female.

B^+B Bald headed male and normal hair female.

BB Normal hair male and female.

Figure (27): Inheritance of baldness trait.

The baldness trait is attributed to the presence of a dominant gene responsible for hair falling and affected only by the musculinity hormones. The phenotype of the hybrid genetic structure is different in male from that of female. The baldness appears in males in two cases: in the pure genotype (B^+B^+) and the hybrid genotype (B^+B) due to the effect of the musculinity hormones. While, the hair falling trait in females appears only in the pure genotype (B^+B^+). The individuals with the genotype (BB) in both sexes do not suffer from hair falling.



Genetic hair falling in females



Genetic baldness in males

Figure (28): The case of genetic baldness in humans

Sex-Limited Traits

There are some traits that are constricted to one sex only due to the differences in sex hormones of each sex. These genes are responsible for the appearance of some traits such as milk production which is limited to the females only, not males. The females have cerain sex hormones help the gene to express its effect. Also, the secondary sexual characteristics in humans such as the beard in men, and also the ability of female birds to lay eggs.

Medical examinations before marriage

Medical examination before marriage is a series of medical examinations carried for the persons who will get married to be sure that they are free from the infectious diseases such as hepatitis and AIDS, as well as genetic diseases such as thalasemia.

These examinations are carried out to give the medical councel about the possibility of transmission of these diseases to the partner or to the offspring in the future. In addition, these examinations provide the choices or alternatives to who will get married in planning for a healthy family.

The marriage of relatives and proceeding without making the medical examinations are considered foctors of genetic diseases spreading out. Medical examinations before marriage help in:

 Giving birth healthy children.

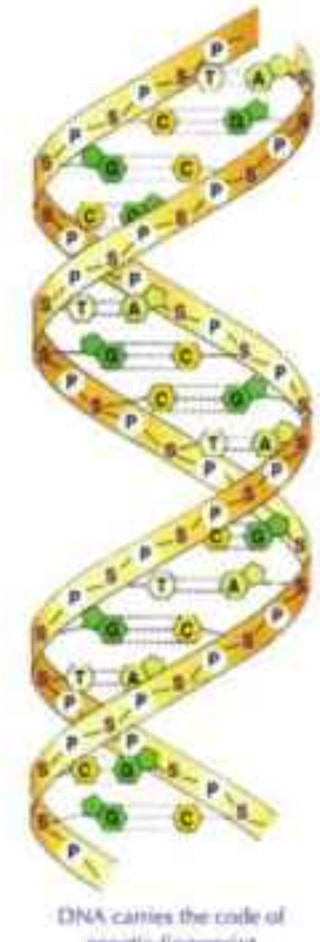

Limiting the spreading out of gentic diseases, congenital deformifies and mental retardation.


Avoiding the financial, psychic, social loads when caring the children infected with genetic diseases.

Science, Technology, and Society

Genetic fingerprint

Genetic fingerprint did not know until 1984. When sir Alec Jeffreys at university of leicester in London puplished a reseach showed that the genetic material may repeat many times. After one year, he stated that these repetitive sequences are unique and chractedristic for each individual. They are imposible to be similar in tow individuals unless in the identical twins only. Dr.Alec recorded the patent of his discovery in 1985. He named these repetitive sequences by the name the human DNA fingerprint. This fingerprint was known as "a mean used to identify individuals through compairing DNA sections (fragments)". Sometims, it is called "DNA typing".

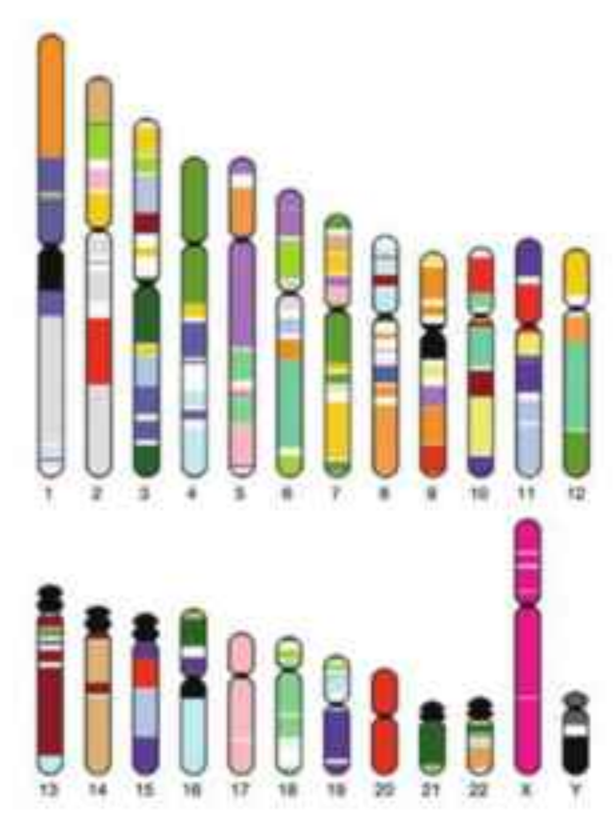

DNA carries the code of genetic fingerprint

The usage of genetic fingerprint started in the medicine. It was used in studying of genetic diseases, operations of tissues implantation and others. It is fastly introduced into field of "forensic medicine", where it was used in identifying the deformed carpses and tracing the missing children. Courts opened the files of crimes registered against unknown persons, and the interrogations opened once again. The genetic fingerprint exempted hundreds persons from killing and ravishment crimes, and incriminate others. It was the decisive word in the cases of ancestries.

Human genome

Human genome comprises all the genes found in the nucleus of each somatic cell. Their number is ranging between 60,000 and 80,000 genes. They are located on 23 pairs of chromosomes. The genes participate in presence of the enormous number of human characteristics. The search for genes started in 1953 when the 2 scientists Watson and Crick proved that the gene is a double helix of the nucleic acid DNA. In 1980, the idea of genome appeared and the number of genes identified by scientists was about 450 genes. At the middle of eighties, this number is doubled three times over to reach 1500 genes. The aim of scientists was the drawing of a good genetic map through the accurate idenification of the locations of genes on the chromosomes. So, the genes causing genetic diseases can be indentified.

Now, scientists aim to benfit from the genome in the field of drugs industry and reaching to drugs without side effects, and studying the evolution of living organisms by comparing human genome with other ones of the other living organisms. Also, they aim to breed improvment through identifying the genes of diseases in the fetus before its delivery and act to improve them.



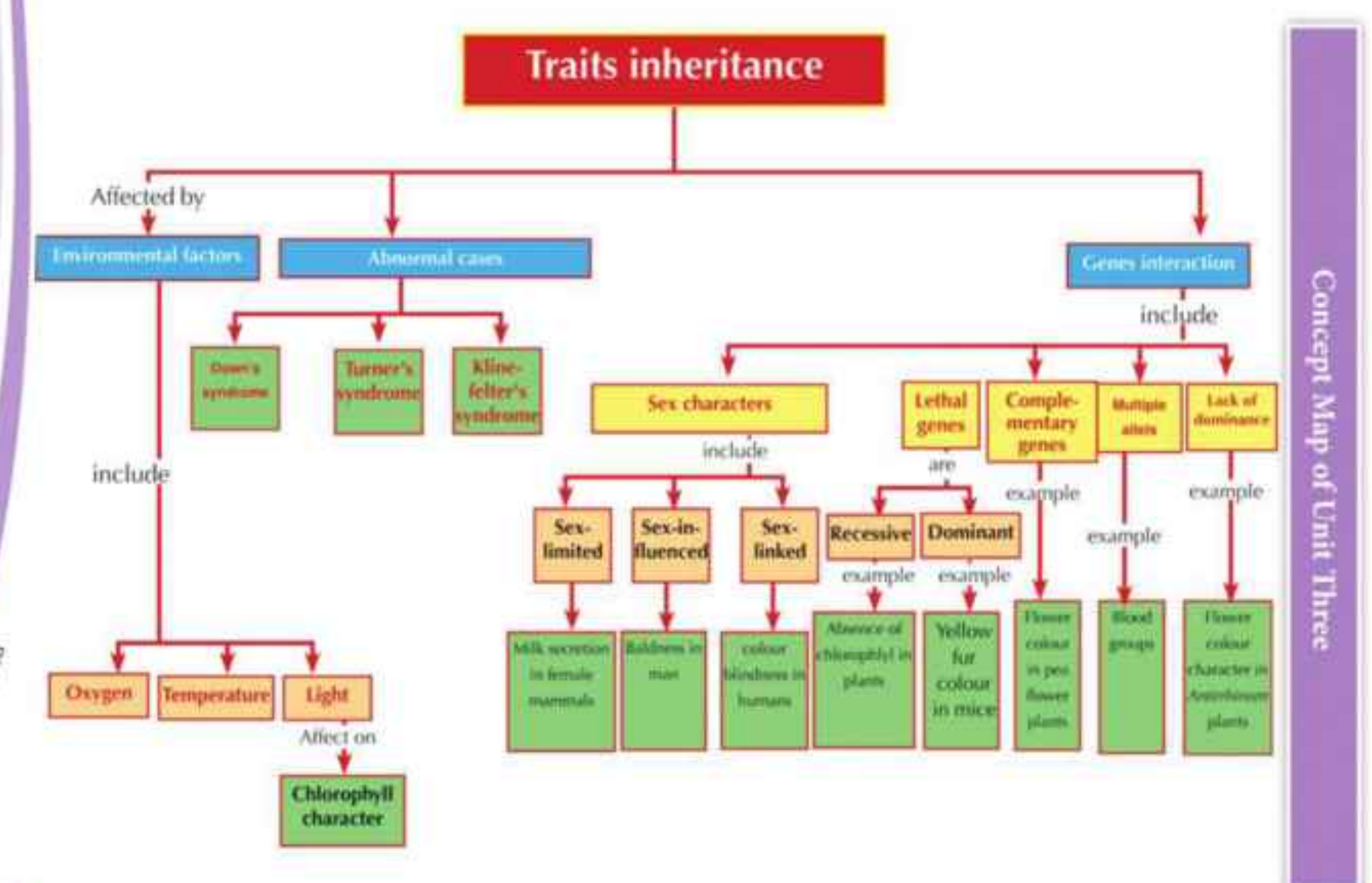
Chromosomes carry thousands of genes.

Key Terms

- **Lethal genes**: The genes that lead to retardation of growth and cause death at different stages of life when they are found in an identical form (pure).
- **Antigens**: Chemical substances found on the surface of red blood cells and determine the transfused blood group.
- **Katyotype**: Classifying of chromosomes into homologous pairs arranged according to their size.
- **Lack of dominance**: A genetic case in which the gene does not dominate over the corresponding gene and they interact to produce a new trait.
- **Sex-linked traits**: Genes of these characteristics are carried on sex chromosomes, and their appearance does not affected by sex hormones.
- **Sex- influenced traits**: Genes of these characteristics are carried on autosomes and their appearance is affected by sex hormones.
- **Klinefelter's syndrome**: An abnormal case resulted due to the presence of an extra (X) chromosome in some males (XXY).
- **Turner's syndrome**: An abnormal case resulted due to lack of one (X) chromosome in some females (XO)
- **Down's syndrome**: An abnormal case resulted due to presence of an extra autosome in the pair of chromosomes number (21).
- **Rhesus factor**: A type of antigens found on the surface of red blood cells in most humans. Three pairs of antigens located on the one chromosome pair control the production of rhesus antigens.

Al-Ashraaf printing House

Concept Map of Unit Three





Applied activity

Model of a karyotype

Safety precautions



Activity goal

Arranging chromosomes to form a karyotype

Acquired skills

Designing , Innovation , Hand working, Classifying

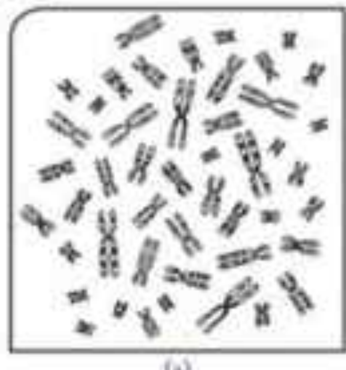
Materials needed

Paper , scissors , waxy adhesive , and pencil

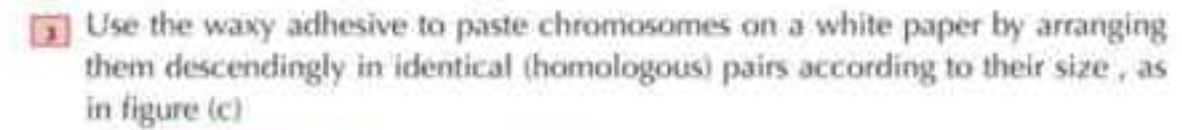


re :

1. photograph and magnify a group of chromosomes using figure (1)



(a)



2. Use the scissors to get cuttings of different chromosomes.
3. Use the waxy adhesive to paste chromosomes on a white paper by arranging them descendingly in identical (homologous) pairs according to their size , as in figure (c)



(b)



(c)

4. Under each chromosomes pair , write the number that indicates its order .
5. How many pair of chromosomes you arranged? ....

Examine the karyotype in figure (c) , then answer the following questions:

6. Does this figure represent a karyotype for a somatic cell or a sex cell?
   Why? ....
7. How many chromosomes in figure (c) ? ....
8. What is the sex of the owner of this karyotype ? ....
   Why? ....

Assessment activity

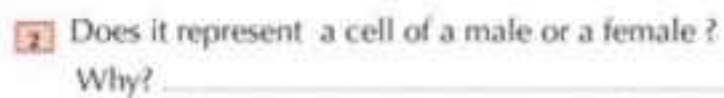
 The opposite figure illustrates the karyotype of a cell.



1. Does the karyotype represent a somatic cell or a sex cell ? Why ?

   ....

2. Does it represent a cell of a male or a female ?

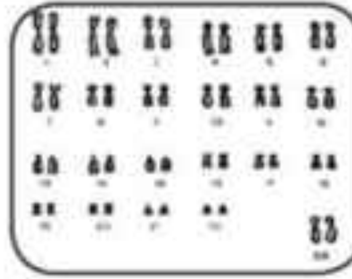
   

   Why? ....

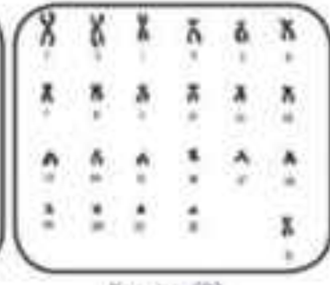
3. How many autosomes ? and how many sex-chromosomes?

   ....

 Check the figure opposite.



Karyotype (A)



Karyotype (B)

1. Which of the 2 karyotypes represents a somatic cell? Which of them represents a sex-cell? Why?

   ....

2. Does karyotype (A) represent a cell of a male or a female ? ....

   Why ....

3. How many autosomes? And how many sex chromosomes are there in both karyotype (A) and karyotype (B) ? ....




Effect of light on chlorophyll appearance in green plants

Safety precautions



Activity goal

Concluding the effect of light on chlorophyll appearance in a green plant

Acquired skills

Observing, Comparing, Recording and Analyzing data, Concluding

Materials needed

Agricultural soil, plastic or pottery container, corn or wheat gains, and water

Procedure :

1. germinate a group of wheat or corn grains in a dark place and an identical group in illuminant place. Irrigate the seedlings regularly for several days.

Observation:

- Record your observations about the colour of seedlings in both groups .

First group : ______________________

Second group ______________________

Is there a relationship between the presence of light and appearance of green colour in seedlings ?

____

Explanation:

- What is the explanation of this relationship?

____



Effect of light absence on colour of wheat seedlings

Conclusion

- What do you conclude from this activity?

____

- Give some examples ensure that appearance of traits is affected by the environmental factors.

____

Assessment activity

1 The following table shows the resulted generation from crossing of 2 strains of pea plants. Answer the following questions:

♀ \ ♂	AB	--	aB	ab
--	(2)	AABb	(1)	AaBb
--	(4)	AAbb	(3)	Aabb

1. What are the genotypes of plants no. 1, 2, 3, and 4? ....
2. Infer the phenotypes of parents. ....
3. What is the percentage of white - flowered plants resulted from this crossing?
....
4. What is the colour of pea flowers resulted from crossing of plant no. (3) and plant no. (4) ?
....

2 The following table shows the four blood groups:

1. Write the genotypes of the following blood groups:
   - Group (A) : ....
   - Group (B) : ....
2. Write down the types of antibodies in their proper places inside the table.
3. Write down the types of antigens in their proper places inside the table

The group	O	AB	B	A
Antibodies	......	......	anti -a	......
Antigens	......	......	......	A

3 Examine the opposite table that shows the results of blood groups detection , then answer the following questions:

1. Identify the expected blood group in each case indicated in the table. ....
2. What is blood group that contains both types of antigens? ....
3. What is blood group that donates blood to all other blood groups?
....
4. If your blood group is (A) and you need to blood transfusion, what are the proper blood groups for you? why?
....

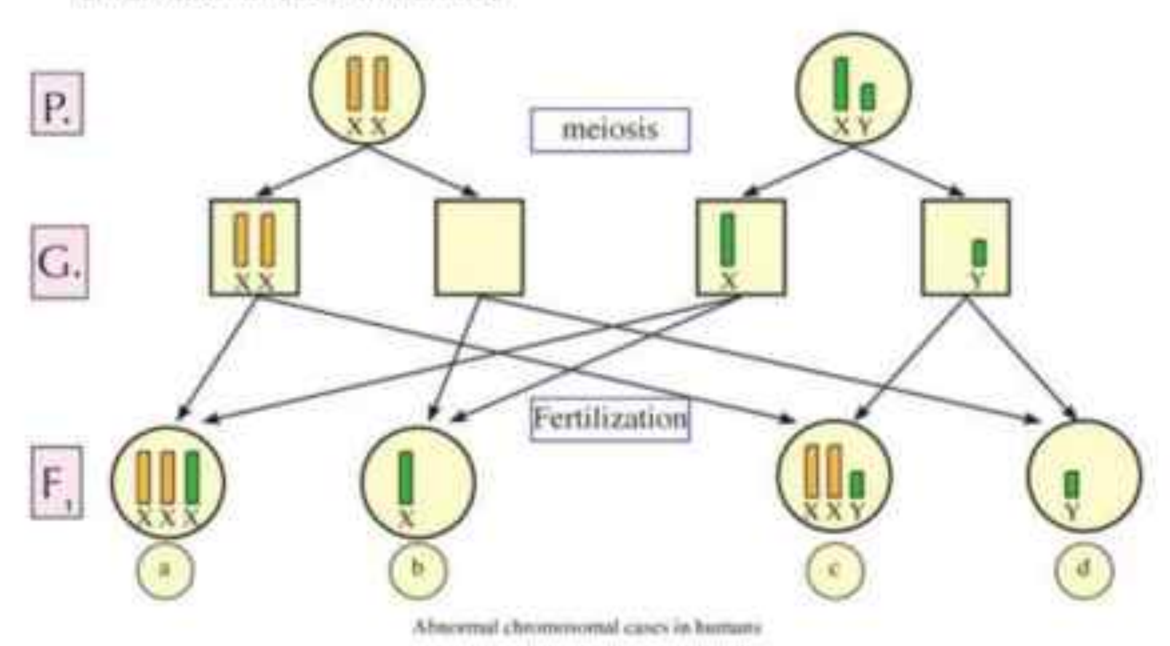
Blood group	anti-a	anti-b
......		
......		
......		
......		

Assessment activity

Abnormal chromosomal cases in humans

Sometimes, during gamete formation by meiosis the sex chromosomes are not equally distributed due to their adhering closely to each other.

- The following figure shows the genetic analysis of some abnormal chromosomal cases in humans



Abnormal chromosomal cases in humans

1. Is the error occurs during the formation of sperms or ovules?

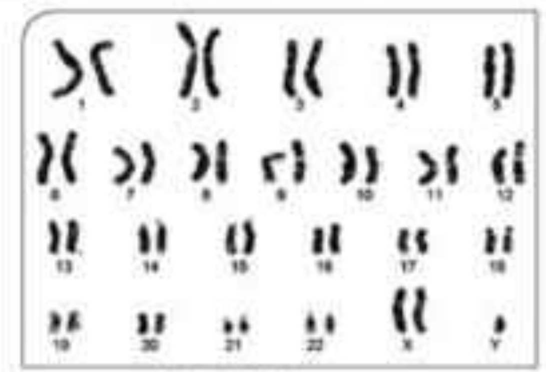
2. how the abnormal case XXX is produced?

3. What is the chromosomal structure resulted from fertilization of an abnormal ovum (22 + XX) by a healthy sperm (22 + Y)?

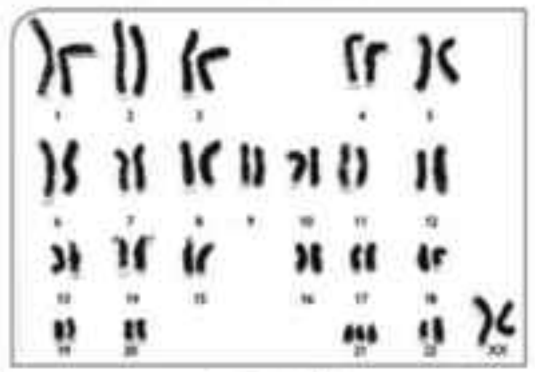
Assessment activity

Studying the karyotype:

1- Study the karyotypes (A) and (B), then record data in the following table:



karyotype (A)



Karyotype (B)

	Karyotype (A)	Karyotype (B)
Type of error	....	....
The name of case	....	....
The sex	....	....
Symptoms	....	....

Examine the 2 following karyotypes, then answer the following questions:



Karyotype (A)

Karyotype (B)

1. How many chromosomes in karyotype (A)?

   ....

   and karyotpe (B)?

   ....

2. Identify the sex of individual from the karyotype (A)

   ....

   And karyotpe (B).

   ....

3. What is the name of the abnormal case that is referred by both karyotypes (A) and (B)?

   ....

4. Mention the symptoms in both karyotypes (A) and (B). ....

   ....

- What is the cause of their occurrence?

  ....

Unit three exercises

First question: Choose the correct answer:

1. The second generation ratio of crossing of 2 individuals differ in a pair of allelic characters in case of lack of dominance is:

A. 3 : 1 B. 1 : 2 : 1 C. 9 : 7 D. 2 : 1

2. The percentage of offspring with blood group (o) resulted from mating of a man with blood group (A B) and a woman with group (O) is:

A. 25% B. 50% C. 0 % D. 75%

3. The blood group that has the two types of antigens is:

A. A B. B C. AB D. O

4. If a parent has blood group AB, he can not give a child with blood group:

A. A B. B C. AB D. O

5. The flower colour character of pea plant represents a case of:

A. Lack of dominance B. Lethal genes C. Multiple genes D. complementary genes

6. The inheritance of yellow colour of mice represents a case of:

A. Complementary genes B. Lack of dominance C. Lethal genes D. d - sex - linked trait

7. The chromosomal structure of Turner's syndrome is

A. XY B. XX C. XXY D. XO

8. The inheritance of milk secretion in cattle is an example of .... traits.

A. Sex - linked B. Sex - influenced C. Sex - limited D. d - Mendelian

9. The case of male Down's syndrome comes from fertilization of a healthy ovum by a sperm:

A. 22 +XY B. 22 + Y C. 23 + Y D. 23 + X

10. When a healthy man marries a colour blinded woman, this disease will appear in .... of their offspring.

A. All males B. All females C. Half of males D. Half of females

Second question: Write the right scientific term:

1. A group of different genes located on a chromosome and inherited together ( )

2. The genes when found in the homozygous state lead to the retardation of growth and cause death to almost one fourth of the offspring at different stages. ( )

3. A type of antigens found on surface of red blood cell, and cause abortion of the pregnant woman. (   )
4. Genetic data displayed in the form of a diagram that shows how a certain trait is inherited and benefits to follow up different traits. (   )
5. The genes influenced by sex hormones and carried on autosomes. (   )
6. An abnormal case resulted from fertilization of an abnormal ovum (22 + XX) by a sperm (22 + Y). (   )
7. An abnormal case resulted from fertilization of an abnormal ovum (22 + O) by a sperm (22 + xy). (   )
8. An abnormal case originates due to presence of excess chromosome in the chromosome pair number 21. (   )

Third question: What would happen in the following cases:

1. A woman (Rh^-) married a man (Rh^+) for their first and second babies.
2. Mating of yellow mice together.
3. Transfusion blood from a person with blood group (AB) to another person with group (A)
4. Germinating seedlings of a corn plant in a dark place.
5. Fertilization of an ovum (23 + x) with a sperm (22 + x)

Fourth question: Give reasons:

1. When 2 individuals differ in a pair of allelic traits, the ratio of second generation is 1 : 2 : 1, not 3:1.
2. Klinefelter's syndrome affects males only, while Turner's syndrome affects females only.
3. Down's syndrome affects males and females.
4. Colour blindness disease is more widespread among males than females.
5. Blood group (AB) is a universal receiver while blood group (O) is a universal donor.

Fifth question: Compare between each pair of the following:

1. Blood group (A) and blood group (B).
2. Lethal genes and complementary genes.

Sixth question: Explain the following cases on genetic bases:

1. A man with blood group (A) married a woman with blood group (B), they gave birth a child with blood group (O)
2. A mother with blood group (AB) has a son with the same group. What are the possible genotypes of the father without a genetic analysis?
3. What is the flowers colour of pea flower plants resulting from the following crossing: AAbb × aaBb ?
4. Crossing of an *Antirrhinum* plant carries red flowers with another one carries pink flowers.

Unit Four

Classification of Living Organisms

No one knows how many several kinds of living organisms on Earth's surface. In spite of human success in describing and naming about 1.4 million kinds of these types till now, biologists are thinking that this number is not representing more than 10% only of the living organisms on Earth's surface. There are millions of insects, small animals and plants that live in oceans which are not yet discovered till now.

Due to the massive diversity in living creatures, the need to the classification process appeared. Scientists classify the living organisms according to their common features in order to make it easier to be studied. In this unit, we are going to know the principles that biologists apply in classifying the living organisms and what are the main groups of living creatures in the light of the modern classification. You will acquire the skill of classifying living organisms according to their characteristics.

For more information about the topic of classifying living organisms, log in the net.

Time Management

To achieve the maximum benefit of this unit, you need to:

- Manage your time between the practical and theoretical study; searching and extending information resources.
- Carefully, record the results of your practical study which is the best way to support your learning.

Learning Outcomes

By the end of this unit; you should be able to:

- Define what is meant by species.
- Describe the way of binomial nomenclature of living organisms and give examples.
- Explain some attempts of classifying living organisms.
- Design dicotomous keys.
- Explain modern classification system.
- Explain the featured characteristics of the five kingdoms, phyla and classes.
- Give examples of kingdomes, phyla and classes.
- Classify some living organism according to the modern classification.
- Appreciate the grandeur of Allah in creating different types of living organisms.
- Appreciate scientists efforts in classifying living organisms and identifying them.
- Follow the scientic method in solving problems.
- Form a positive trend toward the protection of biodiversity.

Unit Four

Chapter 1

Principles of Classification of Living Organisms

By the end of this chapter, you should be able to:

- Conclude some of the classification benefits and importance.
- Define what is meant by species.
- Describe the way of binomial nomenclature of living organisms and give examples.
- Numerate the levels of taxonomic hierarchy of living organisms.
- Use and design the dichotomous key.
- Appreciate scientists efforts in classifying and identifying living organisms.

key terms

- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species
- Binomial nomenclature system
- Dichotomous key
- Taxonomic hierarchy

Most of libraries contain thousands of books in different fields. When you visit any of these libraries to read a specified book, how can you find the book that you are searching for between these enormous numbers of books? Libraries follow a specified system to classify books and categorize them according to their fields, and in each field it divides into small categories with specified subjects and so on till they use numbers to place book on shelves.

By this system it can be easy to find a specific book in the library. We use classification system in our daily life, in addition to books. We classify food, machines and even television programs. Also, scientists use a system to classify living organisms, but how can scientists classify this huge numbers of several kinds of living organisms on Earth's surface?

What is the Importance of classification?

Find the answer of this question through the following link in EKB.



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The classification of living organisms on scientific bases make it easier to identify new organisms, and to add them into their similar groups. Also, classification benefits many other fields of science.

The philosopher Aristotle (more than 2300 years ago) is considered as the first who classified animals into red blooded animals and bloodless animals. Also , he classified plants into trees, shrubs and weeds.

The modern classification depended on the definition of the species as a scientific and basic principle in the classification of living organisms.

❉ What is meant by the species?

Tigon

When mating takes place between a lion female and a tiger male, the tigon is produced (fig. 1). Tigons are sterile as they are unable to mate and reproduce:



Figure (1): Tigon

Mule

Mule is produced by mating of a male donkey and a female horse. Mule is sterile and unable to mate and produce of new generation.



Figure (2): Mule

The term species does not given to tigon or mule because they are unable to mate and produce a new generation of the same kind.

❉ The species: is a group of individuals having similar morphological characteristics, mate with each other and produce fertile offspring similar to them.

Naming of living organisms

There are often different names for the same organism in the various Earth's regions and environments. These names are called the common names.

To overcome this problem, Linnaeus proposed a system for nomenclature of living organisms called the binomial system of nomenclature written by latin language. In this system, each organism was given a binomial name. The first name represents the genus (begins with a capital letter), while the second name represent the species (begins with a small letter). It was agreed to write these names by tilted latin letters, or to underline each of them by a special line to make it different than others. For example, the scientific name of cat is *Felis domesticus*. (Figure 3)



Figure (3): The scientific name of the domestic cat

Enrichment:

Latin language was used to be a scientific language because its words has brief meanings.

In addition, it is an old language and not spoken by people. This protects this language from any change or modification.

Taxonomic hierarchy

There are 7 groups or levels for classifying living organisms. Each group comprises less numbers of organisms, that have more similar characteristics than, that of the group preceeding it. These groups are:

 **Kingdom:**

- Includes a number of phyla.

 **Phylum:**

- Includes a number of classes.

 **Class:**

- Includes a number of orders.

 **Order:**

- Includes a number of families.

 **Family:**

- Includes a number of genera.

 **Genus:**

- Includes a number of species.



Figure (4): Classification of domestic cats

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Species

- Species is an interbreeding population of organisms that can produce healthy, fertile offspring.

- In addition to the previously mentioned groups, there are other groups that intermediate each two successive groups, such as sub - phylum, and sub - class.

Dichotomous key

✍ What will you do to Know the species of a living organism you founded accidently?

You may be try to find it's picture in a book, but this way sometimes is not efficient, may be this organism have different colour from the picture, or even is not existing in the book.

Scientists often use the dichotomous key to help them in identifying living oranisms. Dichotomous key is a series of descriptions ordered in pairs, that leads to identify an unknoun living oramism. Dichotomous key is designed to start with broad features, then it get more specified and more privacy whenever we go through the levels of dichotmous key. Through each step, you can choose one of the two descriptions according to the characteristics of the living organism. By the end, you will reach to a description leads you into the organism's name or the group which it is belonging to.

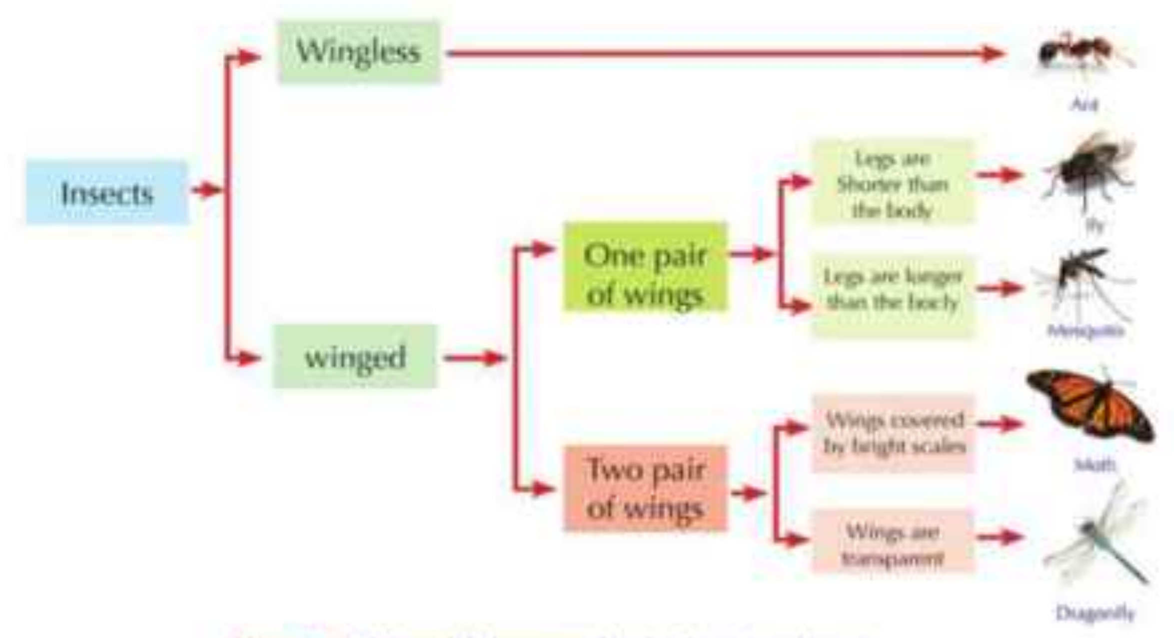


Figure (5): A bilateral dichotomous key for 5 species of insects

Unit Four

Chapter 2

Modern Classification of Living Organisms

By the end of this chapter, you should be able to:

- Explain some attempts to classify living organisms.
- Explain the modern system of classification.
- Explain the characteristic features of the five kingdoms of living organisms.
- Mention examples of living organisms belonging to the Monera, Protista , Fungi and Plantae kingdoms.
- Classify some living organisms in the light of modern classification.
- Appreciate scientists efforts in identifying and classifying living organisms.
- Appreciate the grandeur of Allah in creation the various living organisms.

key terms

- Monera
- Protista
- Fungi
- Plantae
- Animalia
- Non-vascular plants
- Vascular plants
- Ferns
- Gymnospermae
- Angiospermae

In 1700, Carolus Linnaeus established the traditional classification system that classified living organisms in two kingdoms only: Animal kingdom and Plant kingdom.

By the technological advances used in field of biology and increasing of knowledge , the scientist Robert H. Whittaker (1969) established a new system of living organisms classification called the modern system of classification. In this system, living organisms were classified into five lingdoms: Monera, Protista, Fugi, Plantae and Animalia . It is the conventional system in the scientific communities. There are some organisms that are difficult to classify according to Whittaker classification. They include the viruses, viroids and prions.

(1) Kingdom Monera

Kingdom Monera is charaterized by the following characters:

- Unicellular organisms.
- It may live individually or in colonies.
- Cell wall is devoid from cellulose or pectin.
- Many cytoplasmic membranous organelles such as: mitochondria, Golyi apparatus, endoplamic reticulum and plastides are lack.
- It does not contain a definit nucleus , where its genetic matarial is not externally surrounded with a nuclear membrane.
- Monerans are classified into two different groups:

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Archaebacteria

Most of them are often survive in harsh environmental conditions, such as : hot springs, environments with no oxygen, and in highly salty water. This group differs from true becteria in the structure of both cell membrane and cell wall.



Eubacteria

This group includes many widely spread species.

They exist everywhere, in air, on land and in water. Some of them are autotrophic such as cyanabacteria as *Nostoc* (fig.6) while others are heterotrophic. Bacteria reproduce asexually by binary fission. They have various forms where their shape may be spherical , rod - shaped or spiral (fig.7)

Enrichment

Nanobacteria: They are very tiny bacteria. Their size is about 20-200 nanometers. Scientists disagree in considering them as crystalline structures or a new form of life. These bacteria grow slowly inside living cells and their shape change during their stages of growth. They are more resistant than the normal bacteria. They can protect themselves from the defense systems of the body by secreting stony shields surrounding them as a capsule . Researchers reach that this kind of bacteria is a main cause in the formation of kidney stones, atherosclerosis and inflammation of the prostate.



Figure (6): Nostoc



Spiral - shaped bacteria. | Rod-shaped bacteria | Spherical shaped bacteria.

Figure (7): Various forms of bacteria.

(2) Kingdom: Protista

These organisms are eukaryotic. They differ of both plants and animals, where their structere is not complex. Some of them have a cell wall and plastids.

Protists are classified into several phyla, the most important ones are:



Phylum: Protozoa

They are unicellular microscopic animal-like organisms, live in fresh and salty water, as well as in moist soils ; they may live individually (solitary) or in colonies; some are free living and others parasitize plants and animals, causing diseases; they reproduce both sexually and asexually.

Protozoa is classified into four classes depending on the mean of locomotion:

- **Class : Sarcodina**

They move by Temporary extensions from the body called pseudopodia , e.g. ***Amoeba*** (Fig 8).

- **Class : Ciliophora**

They move by cilia surrounding the body , e.g. ***Paramecium*** (Fig 9)

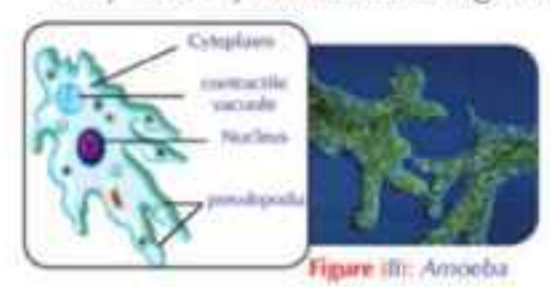


Figure (8): Amoeba

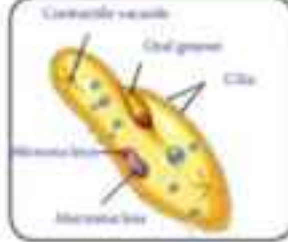


Figure (9): Paramecium

- **Class : Flgellata**

They move by flagella , e.g. ***Trypanosoma*** (Fig.10) which parasitize humans and causes sleeping sickness.


Figure (10): Trypanosoma

- **Class : Sporozoa**

They have no mean for locomotion. They produce phases called spores , e.g ***Plasmodium*** which parasitizes human and infect him with malaria disease.

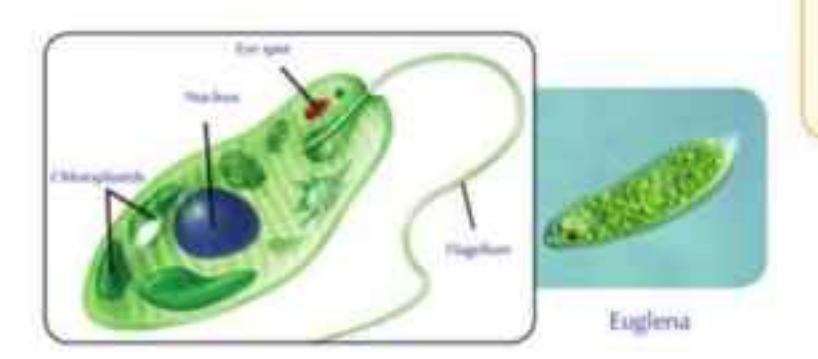
Enrichment

Sleeping sickness: This is one of widespread diseases of the tropical regions. This disease in transmitted by tsetse fly which transfers *Trypansoma* parasite by biting humans. The infected person suffers from fever, heavy sweat, headache , tendency to sleep, hallucination and weakness. Without treatment in proper time, the patient goes into coma which leads to death.



Phylum : Euglenophyta

This phylum comprises ***Euglena*** . They are unicellular living organisms contain green plastids and do photosynthesis . They move by flagella.


Euglena

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Phylum : Chrysophyta

Most of them are unicellular algae called diatoms. Diatoms have glass-like cell walls containing silica. Diatoms are considered as an important source of food for fish and other marine animals (Fig.11).



Phylum : Pyrrophyta

These algae form a great portion of phytoplanktons live in seas and oceans. They acquire a red colour because they contain a red pigment beside the chlorophyll pigment. Dinoflagellates represent the largest group in this phylum. Its members move by two flagellae. (Figure 12)



Figure (11): Diatoms



Figure (12): Dinoflagellates

Enrichment

Red tide: Red tide is a natural phenomenon occurs in seas and oceans water, where water is coloured red. This is accompanied with death of thousands of fishes. This phenomenon is attributed to the enormous increase in numbers of dinoflagellates. When water becomes warm with plenty of nutrients, these organisms repreduce very rapidly and secrete toxins kill fishes.



(3) Kingdom: Fungi

Fungi are characterized by the following characters:

- Fungi are heterotrophic organisms, some are unicellular, and the most are multicellular.
- They are immobile and have cell walls contain legnin.
- They are consisted of filaments called hyphae, and collected together to form mycelium.
- They are heterotrophic, some are parasites and others are saprophytes.
- Most of them reproduce sexually, as well as they reproduce asexually by producing spores.

Fungi are classified depending on their structure and ways of reproduction into live divisions , the most important ones are:

Division : Zygomycota

The hyphae are not divided, spores are produced inside sporangia. Example: ***Rhizopus nigricans*** (bread mould) which causes the black putrefaction on bread. An enzyme used in cheese industry is extracted from this fungus.

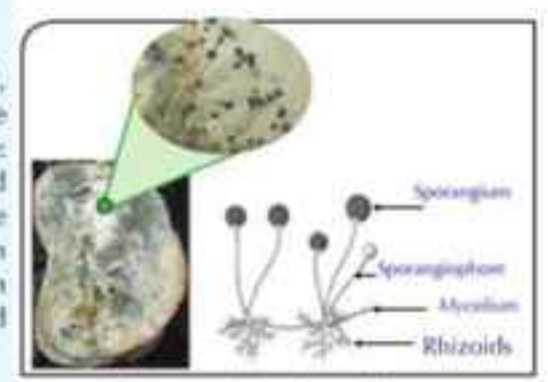


Figure (13): Bread mould fungus

Division : Ascomycota

Some are unicellular such as yeast fungus , and others are multicellular with hyphae divided by septa . They produce spores inside sac-like structures called asci. Example : ***Penicillium*** fungus which produces the antibiotic penicillin.

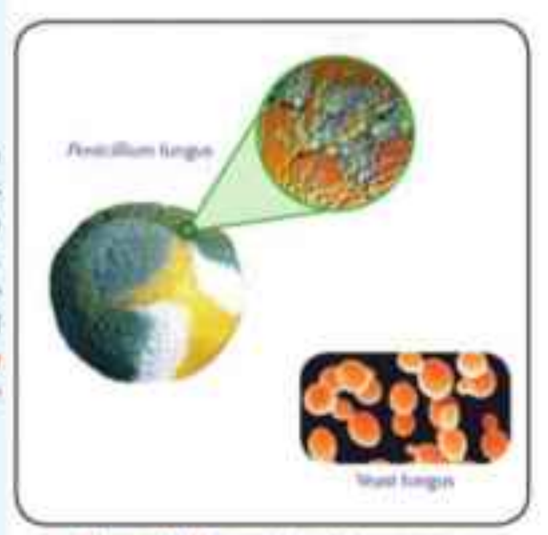


Figure (14): Examples of Ascomycota

Division : Basidiomycota

Their hyphae are divided by septa. Their spores are produced inside a club-shaped structure called basidium. Example : mushroom

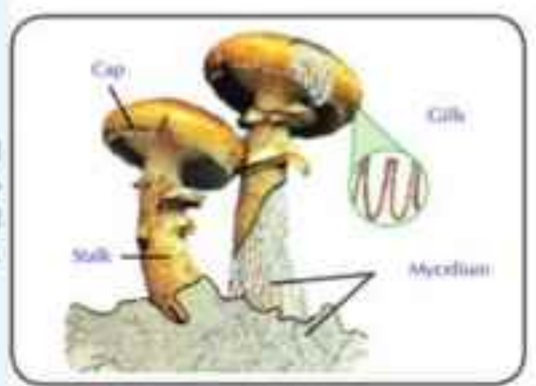


Figure (15): Mushroom fugus

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(4) Kingdom: Plantae

Plants are eukaryotic organisms, characterized by cellulose walls. Plant cells contain the chlorophyll substance in structures called chloroplastids. Most plants repreduce sexually.

Scientists classify plant kingdom into:

a- Higher algae : they include the red , brown, and green algae.

b- Non - vascular plants : include bryophytes (mosses)

c- Vascular plants.



Phylum : Rhodophyta

They are marine weeds sticking together by a gelatenous coat. The cells of these algae contain chromatophores of red pigments. Example : ***Polysiphonia*** (fig.16).



Figure (16): *Polysiphonia*



Phylum : Phaeophyta

They are marine weeds consist of simple or branched filaments . There are chromatophores of brown pigments in their cells. Example : ***Fucus*** (fig.17).



Figure (17): *Fucus*

Phylum : Chlorophyta

These algae contain chloroplastids. Some are unicellular such as ***Chlamydomonas*** (fig.18) and others are multicellular such as ***Spirogyra*** (fig.19) which has the form of unbranched filaments and its cells contain sprial - shaped chloroplastids.



Figure (18): *Chlamydomonas*



Figure (19): *Spirogyra*



Phylum: Bryophyta (Mosses)

This phylum includes the plants which do not contain speciallized vascular tissues, so they are called non-vascular plants. They are terrestrial plants that need dampness greatly to grow and reproduce. Therefore, they live in damp soils and shaded places. They are small, green in colour, and have certain hairs for anchorage which are rhizoids. Some are flat such as ***Riccia*** and others are erect such as ***Funaria*** (fig. 20).



Figure (20): Bryophyte plants



Phylum: Tracheophyta

This phylum comprises the plants which have speciallized vascular tissues for transport of water and minerals (through the xylem) and transport of organic substances produced by photosynthesis (throuhg phloem), so they are called vascular plants. This phylum is classified into three classes:

Class: Filicatae (Ferns).

These plants have simple structure. Most of them are herbs and few are shrubs or trees. They live in shaded damp regions, as well as the wall of wells and shaded damp valleys. They have stems, leaves and roots. Also, they carry pinnate leaves and do not produce flowers or seeds. They reproduce by the spores that found in special structures on the lower surface of leaves. Example: ***Polypodium*** (fig. 21), and **Adiantum**.



Figure (21): A pinnate leaf of *Polypodium*

Class: Gymnospermae or Conifers:

Most of them are trees and few are shrubs. They do not produce flowers. Thy carry male and female cones. They have naked seeds and needle - shaped simple leaves. Example: ***Pinus*** (fig. 22).



Figure (22): ***Pinus*** plant

➡ **Class: Angiospermae or Flowering plants:**

They are terrestrial plants; have stems, leaves and roots; they produce flowers that convert into fruits enclosing seeds. These plants are classified into two groups: Monocotyledons and dicotyledons.



Figure (23): *Fruit of flowering plant (peach)*

Use the following table that help you to identify the differences between the two major groups of flowering plants.

✲ **Table (1):** The taxonomic characteristics of monocotyledons and dicotyledons:

	Seeds	Leaves	Flowers	Stem	Root
Root- monocotyledons					
Dicotyledons					

Monocotyledons	Dicotyledons
• The seed has only one cotyledon. • Bundles of vascular tissues are scattered inside the stem. • Flowers with trimerous whorls or their multiples. • Leaves are narrow and parallel viend. • They have fibrous roots. • Examples: wheat, onion and palm.	• The seed has two cotyledons. • Bundles of vascular tissues are arranged in a ring. • Flowers are either tatramerous or pentamerous. • Leaves are of pinnate or palmate venation. • They have tap roots. • Examples: peas, Beans and cotton.

(5) Kingdom Animalia

They are multicellular, eukaryotic organisms. They have the ability of moving and transporting from a place to another. They have the ability for responding rapidly to external stimuli in the surrounding environment. Their majority reproduce sexually.

- This kingdom will be studied in detail in chapter 3.

Kingdom Animalia

By the end of this chapter, you should be able to:

- Identify the characteristic features of the major animals phyla.
- Give examples of living organisms belonging to animals.
- Classify some living organisms in light of the modern classification.
- Form a positive trend towards the maintaining of biodiversity.
- Appreciate the grandeur of Allah in creation of the various living organisms.

key terms

- Porifera
- Cnidaria
- Platyhelminthes
- Nematoda
- Annelida
- Arthropoda
- Mollusca
- Echinodermata
- Chordata

Scientists classify kingdom Animalia into nine phyla depending upon the degree of the body complexity. Some phyla are without vertebral column and called invertebrates, while others have a vertebral column inside their bodies and called vertebrates.



Phylum: Porifera (Sponges)

The following link in EKB illustrates the charachteristics of sponges





Figure (24): The sponge

Sponges are classified as animals although they are immobile, because they are multicellular, heterotophic, have no cell walls, and comprise few speciallized cells.



Phylam: Cnidaria

- They are aquatic animals; the most are marine, and live individually or in colonies.
- They have no head, and the mouth is surrounded by appendages and extensions called tentacles.
- Body cells are arranged in two tissue layers, the external one contains cnidocytes (stinging cells)

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for defence and capturing of preys (fig. 25). There are a plenty of these cells on tentacles.

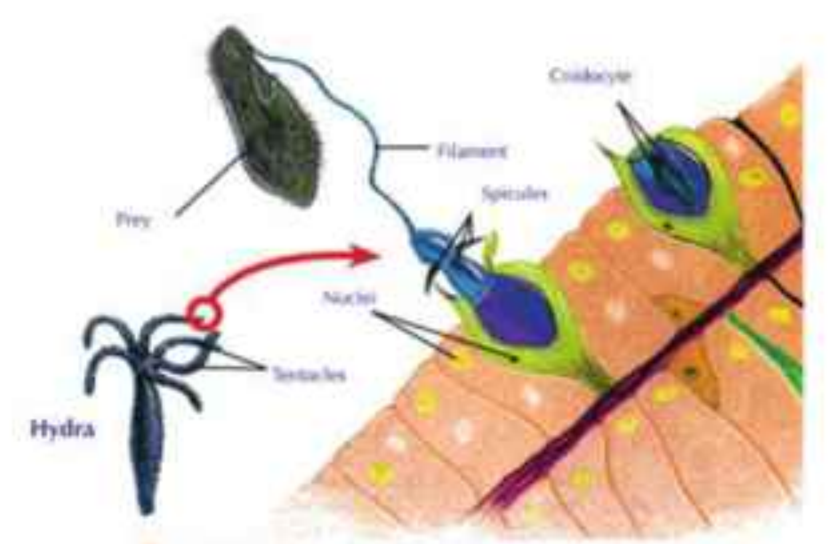


Figure (25): Using of cnidocytes in capturing the preys

- Example of Cnidaria: hydra aurelia and sea anemone.



Figure (26): *Hydra*



Figure (27): *Aurelia*



Figure (28): Sea anemone

- For more information about coral reefs, search at the speciallized internet sites.



Phylum: Platyhelminthes (Flat worms).

Figure (29) illustrates a group of flat worms. Observe these worms, and infer their common features.

Why are these worms called flat worms?



Figure (29): Different types of flat worms

Flat worms are charaterized by the following characters:

- The bodies of these worms are flatened and have a head.
- Their bodies are composed of 3 layers (triploblastic) and bilaterally symmetrical.
- The majority are free living.
- The majority are hermaphrodites.
- Example of flatworms: planaria, bilharzia and tape worms (Fig.29)



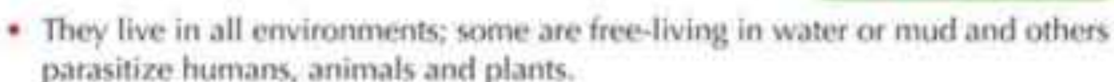
Phylum: Nematoda (Round worms)

Round worms are characterized by the following characters.

- The body is cylindrical, tapers at its two ends and unsegmented. Their sizes are ranging from the microscopic to what may reach 1 meter.
- Their bodies consists of 3 layers and bilaterally symmetrical.
- They have alimentary canal with two openings, the mouth and anus.
- The sexes are separate (unisexual).



Figure (30): Ascaris



- They live in all environments; some are free-living in water or mud and others parasitize humans, animals and plants.

Examples: ***Ascaris*** (Figure.30) and ***Flaria*** worms



Go Further

For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



Enrichment information

Elephantiasis: This disease in caused by a nematode worm called *Flaria* exists in the tropical regions of Asia continent. These worms live inside human blood and lymph vessels. This disease is transmitted by the biting insects, mainly mosquitoes. In cases of heavy infections, the worms may become so numerous that obstruct the flow of fluids through lymph vessels, causing swelling of the infected body parts as shown in the opposite figure.





Phylum: Annelida (Ring or segmented worms):

Earth worms which live inside burrows in the soil **It represent for aeriation and in crease soil ferti pity** common examples.

of segmented worms. This group of worms are characterized by the following characteristics:

- The majority are free-living in the sea, fresh water or the moist muddy soils. Few of these worms are external parasites.
- The body is divided into rings (or segments), and many of them have chaetae (spine-like) buried in the skin and help them to move.
- Some of them are unisexual and the few are hermaphrodites


Figure (31): Earth worm



Phylum: Arthropoda



Go Further

For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



Search and expand

The worm illustrated in the figure is one of annelids (ring worms) called the leech. Use the internet or reference books to search the importance of these worms.

This phylum is characterized by the following characteristics:

- The body is bilaterally symmetrical and divided into a number of segments carry many pairs of appendages. Each appendage consists of many jointed pieces.
- The segmented body is divided into many regions covered by an exoskeleton.



Prawn Crab

Figure (32): Examples of crustaceans

This phylum comprises four classes:

Class: Crustacea

The body consists of two regions (cephalothorax and abdomen) and covered with a chitinous cuticle. They have many jointed appendages adapted in different forms to perform various functions. The eyes are compound. They breathe by means of gills. Examples: prawn, crabs and lobster (fig. 32)

Class: Arachnida

The body consists of two regions (cephalothorax and abdomen). They have four pairs of walking lesgs and breathe by Tracheoles or lung books. Their eyes are simple. They are unisexual. Examples: Spiders and scorpions (fig. 33).


Scorpion Spider

Figure (33): Examples of arachnids

Class: Insecta

The body is divided into head, thorax and abdomen. They have one pair of antennae, a pair of compound eyes, 3 pairs of walking legs and 2 pairs of wings which may be absent as in the majority of ant species or reduced into one pair as in house flies. They breathe by Tracheoles. Examples: flies, mosquitoes, cockroaches, ants, bees, moths and locusts (fig. 34).

Enrichment information

Simple eyes consist of one lens, whereas compound eyes consists of a large number of separted lenses, which work to form a solid image to the object. Each lens photographs adifferent part of the object. the number, area and shape of such lenses differ with respect to the species.



Figure (34): Exampes of insects

Class: Myriapoda

The body is distinguished into a head and a trunk composed of several segments. They have many walking legs. They respire by tracheae. Example: ***Scolopendra*** (fig.35).



Figure (35): Scolopendra



Phylum: Mollusca

This phylum is chracterized by the following characteristics:

- Their majority live in salt water, some in fresh water and a few on land.
- The body is a soft mass, unsegmented and has a mascular part used in locomotion called the foot.
- They have a calcareous shell which may be external or internal, absent or reduced.
- The head is present and well developed (carries sense organs) and may be absent in some of them.
- The majority of molluscs have an organ similar to the tongue called the radulla used in feeding.
- Most of them are unisexual, and the few are hermaphrodites.
- Examples : snails, oyster and octopus. (Fig.36)


Snail


Oyster


Octopus

Figure (36): Examples of molluscs



Phylum: Echinodermata



Go Further

For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



This phylum is characterized by the following chracteristics:

- The body is unsegmented, and has a hard endoskeleton. Some have spines and calcareous plates in body wall.
- They have sucker - like structures called tube-feet.
- The body may be rounded, cylindrical or star-shaped. Some have arms.
- They move by tube feet, spines or arms.
- They are unisexual, reproduce asexually by regeneration and sexually by gametes.
- They have no anterior or posterior end. The bodies of echinoderms majority has two surfaces. The surface in which the mouth is located is called the oral surface and the opposite suffface in called the aboral surface.
- Examples : sea star, sea urchin and seacucumber. (Fig.37)


Sea star Sea urchin Sea cucumber

Figure (37): Examples of echinoderms



Phylum : Chordata





What is the largest phylum in living organisims?

To answer this question use the opposite link in EKB

Sub- phylum: Vertebrata

Notochord first appears in vertebrates in the embryonic stage. It becomes gradually replaced by the vertebral column as the embryo develops. Vertebral column surrounds and protects the spinal cord. Vertebrates also have an endoskeleton. It consists of the vertebral column, skull, girdles and limbs, in addition to presence of a heart formed of many chambers and the blood flows inside blood vessels in a closed circulation to feed all body organs with oxygen and nutrients.

✲ Vertebrates are classified into several classes:

Do you know?

Vertebrates and thermal equilibrium

Body temperature of some vertebrates such as birds and mammals does not change more with the change of environment temperature. Therefore, they are called endothermies or warm blooded animals. They use the energy of food to keep their body temperature constant. Fishes, amphibians and reptiles are belonging to the variable temperature animals, where they can't regulate their body temperature which change according to the change in the surrounding environment. They derive their temperature from this environment. Therefore, they are called ectotherms or cold blooded animals.

Go Further

For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



Class: Agnatha

- They are jawless fishes with a circular mouth similar to the funnel and provided with many horny teeth.
- They have a thin , long and eel - like body with no paired fins. Their skeleton is cartilagenous.
- They are parasites. They stick by their mouth into the big fishes. They attach themselves by the teeth and snap the flesh of these fishes by their rough tongue which is similar to the rasp.

Example: ***Lamprey*** (fig. 38).

Figure (38): *Lamprey*

Class: Chondrichthyes

- They are marine fishes. The endoskeleton is cartilagenous.
- The mouth lies on the ventral surface and provided with several rows of teeth that help them in predation.

- They have paired fins and the body is covered with certain scales similar to the teeth.
- They have no air bladder for floating. Their gill slits are not covered by an operculum. The sexes are separate and fertilization is internal.

Examples: Shark and Ray fish (fig 39)



Shark Ray

Figure (39): Examples of cartilagenous fishes

- **Class: Osteichthyes**

- These fishes live in salt or fresh water
- Its endoskeleton is bony. Their mouth is terminal. The body has paired and medial fins. There is an air bladder inside the body helping in swimming and floating.
- The body is covered with bony scales. Their gill slits are covered with an operculum.
- The sexes are separate and fertilization is external.

Examples: Bolti and Bouri. (fig. 40)





Bouri Bolti

Figure (40): Examples of bony fishes

- **Class : Amphibia**

Go Further

For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



- They are cold - blooded animals.
- They have two pairs of pentadactyl limbs. The

Enrichment

Frogs croaking: If you live near agricultural fields, perhaps you have heard the croaking of frogs. This voice comes from male frogs during mating season for attracting the females for mating. The male can produce this voice because it has a special structure called voice sac which is absent in females.

body is covered with smooth slimy skin.

- The sexes are separate. Fertilization is external. They lay their eggs in water and the embryonic stages live in water and breathe by gills while adults are spent on land and breathe atmospheric air by lungs and skin.

Examples: frog and salamonder (fig. 41)



Salamander Frog

Figure (41): Kinds of amphibians

Class: Reptilia



Go Further

For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



- These animals are cold - blooded.
- The body consists of four regions: head, neck, trunk and tail. They have four weak pentadactyl limbs. Each finger ends with a horny claw. The limbs may be absent, so they move by creeping.
- The skin is dry and is covered with thick horny scales, which may be supported by horny plates.
- They breathe atmospheric air by lungs.
- Sexes are separate. Fertilization is internal and they lay eggs with calcareous or skiny shell.

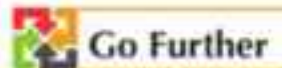
Examples: Lizards, chameleon, gecko, tortoise, snake, and crocodile. (fig. 42)



Chameleon Lizard Crocodile

Figure (42): Kinds of reptiles

Class: Aves



For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



- These animals are warm - blooded.
- The bodies are covered with feathers. They have four limbs, the anterior ones are modified into wings for flying. Each one of hind limbs has four digits provided with horny claws. The hind limbs help in movement on land, climbing, swimming, diving or predation.
- Bones are hollow and light. The sternum is broad for attachment of the strong thoracic muscles which move the wings during flying.
- They breathe by means of lungs. Their bodies contain air sacs act as stores for additional amounts of air during flying.
- The sexes are separate. Firtilization is internal, and they lay eggs and incubate them.

Examples: Pigeons, hens, ducks, hawks, eagles, sparrows and ostrich. (fig. 43)



sparrow



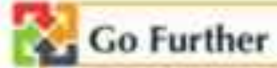
Hawk



Ostrich

Figure (43): Different types of birds

Class: Mammalia



For more knowledge about this topic you can refer to the Egyptian Knowledge Bank (EKB) through the opposite link.



- These animals are warm - blooded.
- The body is distinguished into head, neck, thorax, and abdomen. The skin is covered with hair.
- They have four pentadactyl limbs provided with nails, claws, hooves or pads.
- They are characterized by presence of dissimilar teeth (incisors, canines and molars). The sexes are separate. Fertilization is internal. The majority of them are viviparous. The female has mammary glands which secrete milk to suckle her youngs.
- They breathe by means of lungs.

✲ Class Mamalia is classified into three sub-classes:

Prototheria	Metatheria	Eutheria
These mammals do not give birth, but they lay eggs and incubate them. The eggs hatch youngs suckle milk secreted by mammary glands on the abdomen of the mother. They have a cloacal opening, through which urine, faeces and eggs emerge.	These animals give birth immature young, therefore the mother has to keep it a special pouch at the bottom of her abdomen. The young feeds by suckling milk from nipples inside this pouch.	All these animals are placental mammals. They give birth to fulley developed youngs feeding on milk secreted from the mother's mammary glands.
Examples: Duck-billed Platypus and spiny ant - eater.	Eample: Kangaroo	Eutheria include many of the animals that are headed by human.



Figure (44): Duck - billed Platypus



Figure (45): Kangaroo

✲ Sub-class Eutheria in classified into many oders, from which:

Order	Characteristics	Examples	
Edentata	• Some are without teeth, while the others lost their front teeth only. • They have strong, curved claws.	Armadillo and Sloth	Armadillo
Insectivora	• They feed on insects and their front teeth extend outwards like pincers for capturing of the prey.	Hedgehog	Hedgehog
Carnivora	• They have large pointed canines. • The premolars are sharp, whereas the molars are broad and grinding. • They have strong, sharp curved claws.	Lion, Tiger, Wolf, Fox, Dog, Cat and Seal	Tiger

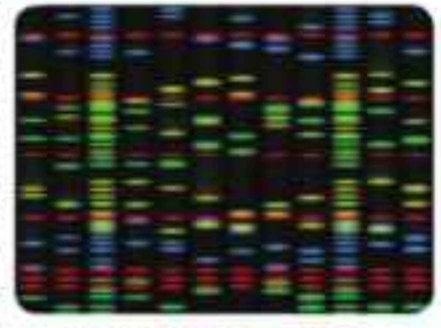
Perissodactyla	• They are herbivore animals. • They are odd-toed (1-3). Each toe has a horny hoof. Their teeth are big-sized and adapted to grind food.	Horse, Donkey, Zebra and Rhinoceros	Zebra
Artiodactyla	• These animals are herbivores. • They are even - toed. Each toe is coated with a horny hoof.	Sheep, Goats, Giraffe, Deer and Camels	Giraffe
Cetacea	• They are huge aquatic animals live in seas and oceans. • The forelimbs are modified to become paddle - like for swimming and the hind limbs are absent. • They breathe atmosphric air by lungs. • Sexes are separate. They give birth and suckle their youngs. • Tail fin is horizontal.	Whale and Dolphin	Whale
Rodentia	• They have sharp chisel-shaped incisors. • The tail is long and ears are small.	Rat, Gerbo. Mouse & Squirel	Rat
Lagomorpha	• The tail is short and ears are long. • They have one pair of incisors in the upper jaw and two pairs in the lower jaw.	Rabbit	Rabbit
Chiroptra	• The forelimbs are modified into wings where the fingers (2nd - 5th) are elongated, and the skin extends between them from the body. • They become active mainly during the night.	Bat	Bat

Proboscida	• They have a long muscular proboscis. • The two upper incisors grow to form what is known as the two elephant canines.	Elephants	Elephants
Primates	• They are the most higher mammals. • They have two pairs of the pentadactyl limbs. The thumb finger lies away from the rest of fingers. • The brain is large in size and nervous system is highly developed in the higher forms.	Monkey, Lemur, Gorilla, Chimpanzee, and Man	Monkey

Science, technology and society

Modern technologies in classification of living organisms:

The studies of first scientists in classification of living organisms depended upon the morphological comparisons to determine the similarities and differences between various organisms. After that (hundreds years ago), scientists turned to classify organisms on the basis of determining the degrees of relevance and relatedness (evolutionary relationships) among them through their researches in the field of comparative anatomy for determining the anatomical similarities in natural structures as skeletal structures and glands, as well as the embryonic development, too.


A technique of DNA analysis.

Nowadays, scientists knowledge of new foundations that can be relied upon to determine the degrees of relevance and relatedness among living organisms were increased through the development of microscopic screening techniques by invention of electon microscope. The recent scientific studies for studying the similarities between the genera of organisms depended on the scientific researches on the nucleic acid DNA existing in the nucleus through DNA sequencing technique. In this technique, the arrangement and sequence of nucleutides of DNA double strand are identified. Scientists found that the greater the sequence in the order of nucleatides in DNA strand, the organisms were more relevant and related.

Frontiers in biology

A more recent use for sponges and cnidarians, especially jellyfish, is in the biomedical and pharmaceutical industries. Researchers have found promising new antibiotic and anticancer compounds in the small percentage of sponge species they have studied. Researchers are also investigating possible medical uses for the paralyzing possible medical uses for the paralyzing toxins that some jellyfish use to capture prey. This branch of biotechnology is quite new, but very exciting. Research will probably result in the development of new medicines.


Jellyfish

Key terms

- **Kingdom:** the highest level in taxonomic hierarchy of living organisms.
- **Phylum:** A taxonomc level represents the biggest group of the kingdom and composed of classes.
- **Species:** A group of individuals which have similar morphological characteistics and mate to produce fertile offspring similar to them.
- **Dichotomous key:** A series of descriptions ordered in pairs and guide the user to adentify the species of an unknown living orgunism.
- **Viruses:** The organisms that gather both characteristics of living organisms and non-living things.
- **Monera:** Unicellular prokaryotic organisms, their cell wall is devoid of cellulose or pectin and they also are devoid of several membranous organelles.
- **Protista:** Eukaryotic, non-complicated structured organisms, some have cell walls and plastids, their majority are unicellular and few are multicellular.
- **Bryophyta:** Terrestrial plants, contain no vascular tissues, and greatly need wetness for growth and reproduction.
- **Ferns:** They are structurally simple plants containing vascular tissues, live in shady wet areas and reproduce by spores.
- **Portifera (sponges):** They are structurally simple aquatic animals with asymmetric bodies containing many pores and canals.
- **Cnidaria:** Aquatic animals, their bodies are radially symmetrical and provided with stinging cells.
- **Arthropoda:** A group of animals, their bodies are divided into a number of segments carry several pairs of appendages, each one consists of several jointed pieces.
- **Mollusca:** A group of animals characterized by a soft body covered with a dermal tissue called mantle that secretes a protective calcareous external or internal shell.
- **Echinodermata:** A group of animals characterized by a rigid endoskeleton, and many of them have spines, prickles and calcareous plates in their body wall.
- **Chordata:** A group of animals, their embryos are characterized by presence of a skeletal structure at their dorsal region called the notochord.

Al-Ashraaf printing House

Summary of living organisms classification

Kingdom	Phylum	Subphylum	Class	Sub-class	Order	Examples
Monera	Archaebacteria					
	Eubacteria					*Nostoc* and several types of bacteria
Protista	Protozoa		Sarcodina			Amoeba
			Ciliophora			*Paramecium*
			Flagellata			*Trypanosoma*
			Sporozoa			*Plasmodium*
	Euglenophyta					*Euglena*
	Crysophyta					Diatoms
	Pyrrophyta					Dinoflagellates
Fungi	Zygomycota					*Rhizopus* (Bread mould)
	Ascomycota					*Penicillium* - Yeast
	Basidiomycota					Mushroom
Plantae	Rhodophyta					*Polysiphonia*
	Phaeophyta					*Fucus*
	Chlorophyta					Clamydomonas- spirogyra
	Bryophyta					*Riccia - Funaria*
	Tracheophyta		Ferns			*Adiantum & Adiantum*
			Gymnospermae (conifers)			*Pinus*
			Angiospermae (Flowering plants)	Monocotyledonae		Wheat - Onion - Cactus - Maize
				Dicotyledonae		Bean-Pea - Cotton
Animalia	Porifera					Sponge
	Cnidaria		Hydrozoa			*Hydra*
			Schyphozoa			*Aurellia*
			Anthozoa			Sea anemone-*Alcyonium*
	Platyhelminthes		Turbellaria			*Planaria*
			Trematoda			*Bilharzia*
			Cestoda			Tape worm
	Nematoda					*Ascaris - Filaria*

Kingdom	Phylum	Subphylum	Class	Subphylum	Order	Examples
Animalia	Annelida					Earth worm - Leech
	Arthropoda		Crustacea			Prawn - Crab
			Insecta			Flies - Mosquitoes - Bees - Cockroaches - Moths - Locusts
			Arachnida			Scorpion - Spider
			Myriapoda			Scolopendra
	mollusca		Gastropoda			Snails - Slugs
			Bivalvia			Oysters - Mussels
			Cephalopoda			Octopus - Sepia
	Echinodermata		Asteroidea			Sea star
			Echinoidea			Sea urchin
			Holothuroidea			Sea cucumber
	Chordata	Vertebrata	Agnatha			Lamprey
			Chondrichthyes			Shark - Ray
			Osteichthyes			Bolti - Bouri
			Amphibia			Frog - Salamander
			Reptilia			Chamaeleon - Snake - Lizard - Crocodile - Turtle
			Aves			Ostrich - Pigeon - Hawk
			Mammalia	Prototheria		Duck - Billed Platypus - Spiny ant - eater
				Metatheria		Kangaroo
				Eutheria	Edentata Insectivora	Armadillo - Sloth
					Carnivora	Hedgehog
					Perissodactyla	Lion - Tiger - Wolf - Dog - Cat - Seal
					Artiodactyla	Horse - Donkey - Zebra - Rhinoceros
					Cetacea	Sheep - Goat - Giraffe - Deer - Camels
					Rodentia	Whale - Dolphin
					Lagomorpha	Rat - Gerbo - Mouse - Squirrel
					Chiroptera	Rabbit
					Proboscida	Bat
					Primates	Elaphant
					Primates	Monkey - Gorilla - Chimpanzee - Man



Applied activity

Designing a taxonomic key

Safety precautions



Activity goal

Classifying a group of leaves and designing a dichotomous key that can be used to identify the leaves.

Acquired skills

Observing, organizing, Classifying, Designing, Recording and analyzing data, Concluding.

Materials needed

6 - 10 different types of leaves, a ruler, magnifying hand lens.

Procedure:

1. Gather a group of leaves that are different in shape and size from your environment.



2. Identify the characteristics you will use for classifying the leaves.

Size: ______________________

Colour: ______________________

Shape: ______________________

3. Design a dichotomous Key you will use to classify the leaves.

____

____

____

____

____

____

4. Revise your key as needed, to make it easier to use.

Are there other ways in which you could have grouped the specimens ? Describe these alternate ways.

____

- Compare the key you have designed with that designed by your colleagues in the group.

____

____

Practical activity 

Shapes and characteristics of bacteria

Safety precautions



Activity goal

Examining different types of bacteria and classifying them according to their shape.

Acquired skills

Working in a team, Examining, Observing, Scientific, drawing, recording and analyzing data, Classifying, Interpreting Concluding.

Materials needed

Slides of the 3 types of bacteria [spherical (cocci), rod-shaped (bacilli) and spiral - shaped (spirilla)], light microscope with an oil immersion lens.

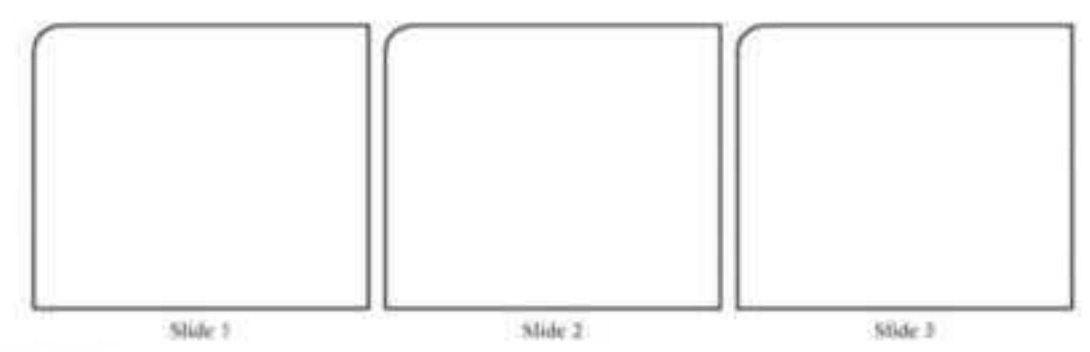
Cooperate with your colleagues in the group for examining slides, demonstrating observations, exchanging the views and comparing the results with that of other groups. Then participate in expressing an opinion through the group discussion which carried out under the supervision and guidance of your teacher.

Procedure:

1. Examine using the microscope each of the three numbered slides (1 - 3) that your teacher has given you.
2. Make a rough sketch of each bacterium, and classify it as either cocci, bacilli, or spirilla .

Observation and scientific drawing:

1. What did you have observed in each of the 3 slides?
   - Slide (1): ....
   - Slide (2): ....
   - Slide (3): ....
2. Draw a diagram for what you observed in each type of bacteria.



Classifying:

1. What is the criterium used in classifying these three types of bacteria?

   ....

2. What are the differences between the shapes of these 3 types of bacteria?
   - The type of bacteria in slide (1): ....

- The type of bacteria in slide (2): ....
- The type of bacteria in slide (3): ....

2 What are the similarities in the specimens you examined? ....
....

Practical activity 

Examining protists in pond water

cooperate with your colleagues in the group for carrying out the procedure of this activity and discussing, comparing and interpreting the results.

Safety precautions

Activity goal

Examining a sample of pond water, indentifying protists exist, and specifying the mean of locomotion in each of them

Acquired skills

Working in a team, observing, recording and analyzing data, interpreting Concluding.

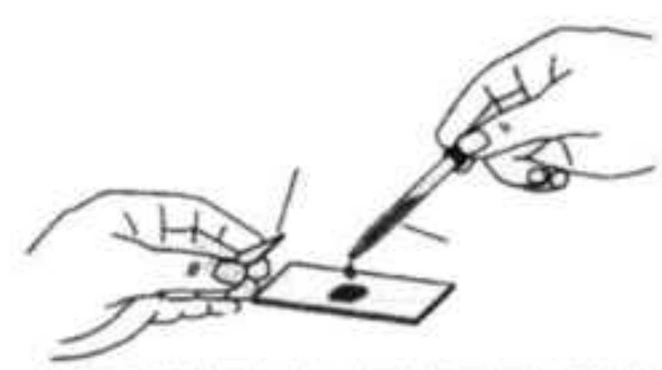
Materials needed

Pond water, glass slides, coverslips, compound light microscope, glass rod, and dropper.

After that a group discussion will be conducted under supervision and guidance of your teacher to interpret the results to come into a conclusion.

Procedure:

1. Bring a small, fresh sample of pond water.
2. Place a drop of pond water on the slide, and cover it with a coverslip.
3. Use the microscope to examine pond water under low power objective lens.



A figure illustrates how is a drop of pond water placed on the slide, then covering it using a coverslip to examine it microscopically

➡ Drawing and data recording

3 Sketch the organisms you see and record how each of them moves.

Describe the different organisms which you observe in pond water ____________

____

Conclusion:

- What do you conclude from this activity? ____________

____

Practical activity

Examining Ferns

Safety precautions

Activity goal

Examining a leaf of fern plant and identifying its characteristics.

Acquired skills

Observing, Scientific drawing, Recording and analyzing data, Concluding.

Materials needed

Fern plant, hand lens, water and plastic dropper.

Procedure:

1 Your teacher will give you green leaves of a fern plant to examine.

2 Use the hand lens to examine the upper and lower surfaces of the fern leaf. Record your observations.

3 Sketch the fern leaf and illustrate the structures appear on its lower surface.

Conclusion:

- What are the structural characteristics of the fern leaf? ____________

____

practical activity 

Examining a flowering plant

Safety precautions



Activity goal

Examining different parts that the flowering plants consists of and identifying whether it is different in the appearance, texture and flowers from other flowering plant or no.

Acquired skills

Working in a team, Observing, Scientific drawing, Recording and analyzing data, Concluding.

Materials needed

Flowered bean plant, flowered lily plant, and hand lens.

Cooperate with your colleagues in the group for carrying out this activity, demonstrating observations, exchanging the views and comparing the results with that of other groups. Then participate in expressing an opinion through the group discussions carried out under the supervision and guidance of your teacher.

Expectation: Knowing the main parts of the flowering plant

procedure:

1. Observe the plant of your group and draw it. Label the names of plant parts as you can.
2. Use the hand lens to observe the plant parts in more detail. Record your observations about the appearance of those parts and their structure.



Lily plant



Bean plant

Observation and scientific drawing:

1. Observe different parts of the flowering plant. What are these parts? ....

....

2. Sketch the plant, and label the names of its parts.

➡ Analyzing data

1. Compare the results of your group with that of other groups in the following table.

Comparison points	1st group (Bean plant)	2nd group (Lily plant)
Roots:	....	....
Leaves:	....	....
No. of floral whorls:	....	....

2. Are all flowering plats share the same parts?

....

....

➡ Conclusion:

- What do you conclude from this activity?

....

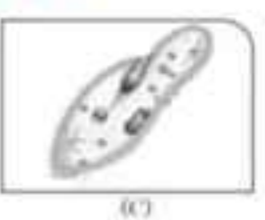
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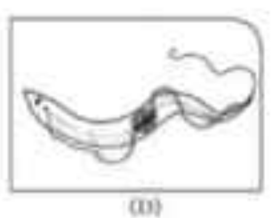
Assessment activity

➡ The following figures illustrate some protists:


(A)


(B)


(C)


(D)

1. Specify the phylum and class that each organism belongs to.

- (A) ....
- (C) ....
- (B) ....
- (D) ....

2. Identify the mean of locomotion for each organism.

....

➡ When two pieces of bread, one of them is dry and the other id wet, were leaved in a warm place for 3 - 4 days, the results were as the following :


The dry bread piece


The wet bread piece

When examining the developing mould on the wet bread piece using microscope, the following organisms were observed:

1. What is the cause of change occurred to the wet piece of bread?

....

2. What is the source of change occurred to the wet piece of bread?

....



3. Why did not a change occur to the dry piece of bread as the wet piece? ....

4. Specify the phylum that these developing organisms on the wet piece of bread are belonging to.

....

Practical activity 

Examining earth worms

Safety precautions



Acquired skills

Observing, Describing, Analyzing, Concluding.

Activity goal

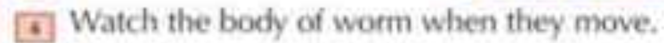
Identifying the characteristic features of earth worms.

Materials needed

Earth worms in a container of damp soil, old newspapers (or white papers), forcepses, magnifying lens, and plastic rulers.

Procedure:

1. place the worms over newspapers.
2. Determine the length of a worm using the ruler.
3. Let the worms move.
4. Watch the body of worm when they move.



5. Try hearing the sound of worms movement.



6. Catch a worm and pass your fingers on the ventral surface from back to front.
7. Count the segments in earth worm body.

Observation and data analyzing:

1. Describe the external shape of earth worm. ....
....
2. Describe the movement of earth worm and explain how its external structures allow movement. ....
....
3. What is your felling when you passed your fingers on the ventral surface of the worm? ....
....
4. Do you hear a sound when the worm moves on the paper? ....
....

Conclusion

1. Conclude: What are the characteristic features of annelids (ring worms) such as earth worms? ....
....
....

Practical actively 

Comparing reptiles with amphibians

Safety precautions:



Activity goal

Comparing the prominent morphological characteristics of a reptilian animal and amphibian one

Acquired Skills

Observing, Recording and analyzing data, Concluding.

Materials needed

Preserved specimens of lizards and toads

Cooperate with your group colleagues in carrying out this activity, demonstrating observations, exchanging the views and comparing the results with that of 2 other groups. Then, participate in expressing an opinion through the group discussion which carried out under the supervision and guidance of your teacher.

Identify which of the structural characteristics can be used for distinguishing and comparing between reptiles and amphibians ....

....





Procedure:

1. Observe both the lizard and toad without touching. Describe what to do you see.

Observation and data recording:

1. Observe both the lizard and toad. Describe the most important morphological structures for both.

- Toad's characteristics: ....
- Lizard's characteristics: ....

Analyzing data:

1. What is the more obvious difference between the morphological structures of both the toad and lizard? Mention the other differences you observed. ....

....

2. How does the skin of both animals seem? ....

....

Conclusion:

What are the external structures that can be used for distinguishing between reptiles and amphibians? ....

Applied activity 

Animals classification

Safety precautions



Activity goal

Classifying different kinds of animals according to the distinguishing characteristics of each.

Acquired skills

Working in a team. Observing, classifying.

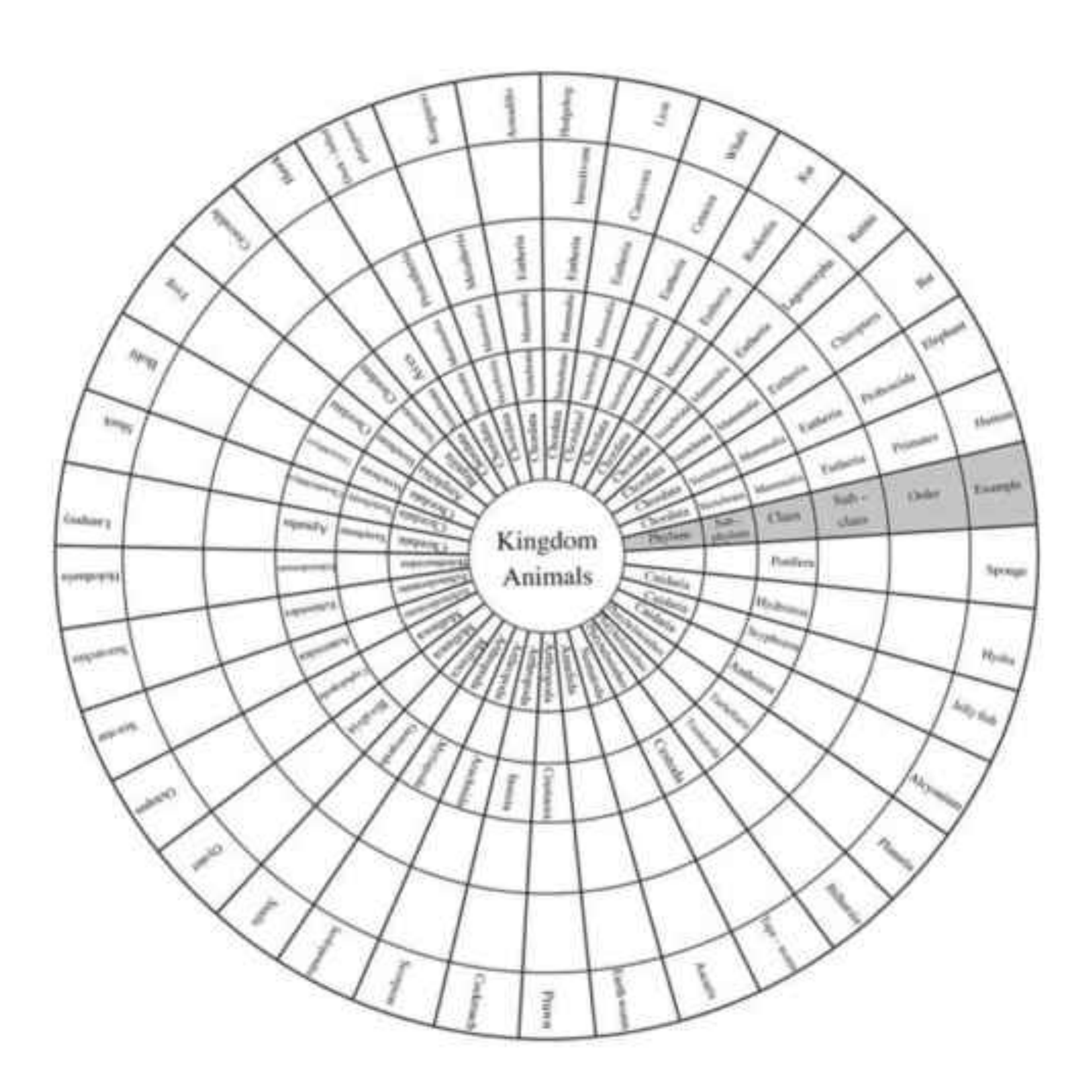
Materials needed

Compass, cardboard, and scissors.

Share a group of your colleagues in carrying out this activity. Debate and exchange views in every attempt before making sure the correct answer shown in the model.

Procedure:

1. Use the compass and scissors to design a disc of cardboard of a radius 8 cm.
2. Place this disc over the circle shown in this activity, so the 2 centers of both circles are coincide together.
3. Cut a section of the disc, so the shaded part of the circle appears.
4. Start the activity by choosing one of animal examples, then determine the order, class and phylum that this example belongs to
5. Discuss your group about the answer you reached, then make sure the correctness of the answer by moving the disc, so the cut section of disc faces this example.


Kingdom
Animals
Phylum
Class
Order
Example
Porifera
Sponge
Hydra
Jelly fish
Prawn

Applied activity 

Designing a concept map

Design a concept map using the following terms:

Birds	Mammals	Skin covered with hair	Reptiles
Pulmonary breathing	Amphibians	Scales	Viviparous animals
Feathers	Horny scales	Weak limbs	Vertebrates
Cutaneous (skin) breathing	Hollow bones	Fishes	Gills

Fourth unit excercises

First question: Write the scientific term for each of the following statements:

1. The highest taxonomic level in taxonomic hierarchy of living organisms classification. ( )
2. A series of characteristics ordered in pairs that help the user to identify an unknown living organism. ( )
3. A type of bacteria has the ability to survive in harsh environments. ( )
4. A type of fungi produces spores inside club - shaped structures. ( )
5. The plants that their seeds produced inside a pericarp. ( )
6. The plants that have fibrous roots and paralle veined leaves. ( )
7. The aquatic animals that their bodies are provided with stinging cells. ( )
8. A type of worms that has a cylindrical body and tapered at its ends. ( )
9. Terrestrial plants live in damp soils , reproduce by spores , some are erect and others are flat. ( )

Second question: Choose the correct answer:

1. From the plants which contain cones:

   A. Maize (corn) B. Pea C. Pinus D. wheat

2. From the examples of annelids (ring worms):

   A. Liver fluk B. Ascaris C. Arachnids D. Earth worm

3. Prawn is belonging to class:

   A. Insecta B. Crustacea C. Arachnida D. Myriapoda

4. Octopus belongs to phylum:

   A. Echinodermata B. Mollusca C. Cnidaria D. Sponges

5. From the examples of echinoderms:

   A. Sea urchin B. Jellyfish C. Snails D. Prawn

6. Sponge animal is belonging to phylum:

   A. Cindaria B. Porifera C. Mollusca D. Arthropoda

7. From the examples of insects:

   A. Hony bees B. Crab C. Sand worm D. Scorpion

8. Yeast belongs to kingdom:

A. Plantae B. Animalia C. Fungi D. Monera

9. From the warm - blooded animals:

A. Fishes B. Amphibians C. Mammals D. Reptiles

Third question: Give reasons for each of the following:

1. Mule is not considered a species
2. Bacteria are classified as monerans.
3. Ascaris worm is a nematoda while earth worm is an annelid.
4. Palm plant is classified as a monocotyledon.
5. Despite the bat ability to fly, it is classified as a mammal , not a bird.
6. Kangaroo is classified as a metatherian animal.

Fourth question: Compare between each pair of the following:

1. Monocotyledons **and** dicotyledons
2. Birds **and** reptiles
3. Insects **and** arachnids

Fifth question: Classify the following organisms into their phyla and classes

1. Amoeba
2. Mushroom
3. Trypanosoma
4. Toad
5. Jellyfish
6. Hawk
7. Honey bees
8. Snake

Miscellaneous questions:

1. What are the cnidocytes (stinging cells) ? What is the phylum that comprises animals containing these cells?
2. What are the distinguishing characteristics of birds bones which help them to fly?
3. what is the mammalian animal that keeps its young in a sac at the bottom of its abdomen ? Why?
4. Mention the conditions that followed when writing the scientific names of living organisms.

المواصفات الفنية:

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